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THE AMERICAN

GAS LIGHT JOURNAL

REDMAN & KENNY, N.Y.

PUBLISHING OFFICE No. 32 PINE STREET

DEVOTED TO THE INTERESTS OF ILLUMINATION, HEATING, MECHANICAL, CHEMICAL AND GENERAL SCIENCE.

VOLUME LXVII.—No. 17. Whole No. 1,168. | NEW YORK, MONDAY, OCTOBER 25, 1897. | $3 PER ANNUM, IN ADVANCE.

A. M. CALLENDER & CO., Proprietors. C. E. SANDERSON, Manager.
THOMAS J. CUNNINGHAM and ELBERT P. CALLENDER, Editors.

ENTERED AT THE POST OFFICE AT NEW YORK, N. Y., AS SECOND-CLASS MATTER.

Published on each Monday of the year, at No. 32 Pine Street, New York.

Collections are invariably made directly from this office for subscriptions, advertisements, etc. We have agents to solicit the same, but they are not authorized to receipt for money.

The Public Lighting Tables of the American Meter Company will be found in the page advertisement of that Company.

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[Special Editorial Correspondence.]

THE SILVERY AGE OF THE AMERICAN ASSOCIATION.

FORT MONROE, VA., Oct. 21, 1897.

Dear JOURNAL: It is a far hark back to the spring of 1862, but the actual presence of two rugged samples of Uncle Sam's Navy—the *Tennessee* and *Indiana*—riding easily at anchor in the waters that rise and fall before the very piazzas of the Hotel Chamberlin, recalls the tragedy of that year, when not so far from here, the *Monitor* and *Merrimac* fought their momentous duel. Unfortunately, then, it was war; now, happily, it is peace. In '62 the thunder of battle and the carnage of conflict were the music that marked the paces on the decks of the contesting vessels; yesterday and to day the measured rythm of trained musicians floated out in harmonious sequence, guiding steps not practiced much in time of war, but nevertheless well known to the men of the *Indiana* and the *Tennessee*. Then, too, is old Fortress Monroe—its name of 30 years ago—now it is a Fort; but with the shortening of its name came an increasing of its strength, for the Fort of to-day is to the Fortress of '62 as youth is to old age. However, as one reminiscence leads to another yet more reminiscent, and as the meeting place of the American Association, on the occasion of its silver wedding, fairly abounds in suggestions that belong properly to the historian rather than the recorder, I might better cease ruminating, and note in succinct order the crop of events that marked the meeting. In the first place, the attendance is sufficient to completely uphold the action of the gentlemen who last year advocated the "Fort" as a suitable meeting place, and a further noteworthy fact in connection with it is the presence of at least three score of the gentler sex, for whose welcome and occupation, during the times of the technical sessions, the committee of arrangements has been quite up to providing. The Hotel Chamberlin is simply a marvel of all that is worthy in a seaside hostelry, which tribute is made by everyone who has experienced the affable graciousness of Manager Swett, who is well worthy of wearing the Chamberlin mantle. With such generally comforting conditions, in a meeting room consonant with the general housings of the hotel, and confronted by a well thought out and specifically prepared programme on the part of the executives, it is little wonder that President Nettleton—"a bit" browner for that hurried European trip—and Secretary Forstall—none the less studious appearing for his permanent domiciliation in "the Oranges"—had no trouble in taking up the regular order.

The first important thing to hand was the report of the Council, which was more than ordinarily interesting this year. Its lines showed applications for active membership from 19, and 9 for associate (all of whom were eventually elected), and a recommendation that the Honorary List be increased by the placing thereon of the names of Mr. Corbet Woodall, President of the Incorporated Institution of Gas Engineers (England), and Mr. George T. Livesey, of the South Metropolitan Company, of London. It is needless to say that both gentlemen were elected; and in remarking that it is a pity some third man doing business in gas circles in the States was not listed for like promotion, we in no sense are to be taken as even thinking that the Englishmen named have not fully deserved the American ranking put upon them at Fort Monroe. A rather revolutionary power was bestowed upon the Council, in the instance of providing an "emergency" way of shifting time and place of meeting. Following this was an acceptance of the offer of Mr. W. R. Beal, of New York, who proposes for competition each year a gold medal, to be awarded to the writer who prepares the best paper read at each of the annual meetings. The medal is to be known as the "Beal Medal," and the jury to award it is to be composed of three Past Presidents of the Association. No flaws were found in the report of the Secretary and Treasurer, nor in the report of the Finance Committee. The report of the Committee on Education (in the absence of the Chairman, Mr. Walton Clark), was read by Secretary Forstall, and its chapters disclosed the pleasing fact that very much good work had been accomplished. The Committee, of course, was continued. The next thing in order was President Nettleton's address, which was quite characteristic of the man. It was connected and "regular," and should be satisfactory to those interested in the gas business, either as engineers or as financiers. A decidedly un-English thing about it, however, was the recommendation that the Association persevere in holding its meetings in out-of-the-way places. The address was followed by Mr. Kerr Murray Mitchell's paper on "A Method Suc-

cessfully Employed to Obviate Trouble from Naphthaline," after which a recess was ordered. The proceedings of the afternoon of the first day were opened by the reading of a couple of invitations—one from the State officials of Tennessee, asking the members to take a "look in" at the Centennial Exhibition now underway in Nashville; the other from the proprietors of the Newport News Shipbuilding and Dry Dock Company, Newport News, Va., giving to the Association the freedom of their yards. The election for officers resulted as follows:

President—J. B. Crockett, San Francisco, Cal.
First Vice-President—A. C. Humphreys, New York City.
Second Vice-President—Geo. G. Ramsdell, Philadelphia, Pa.
Third Vice-President—E. G. Pratt, Des Moines, Ia.
Secretary and Treasurer—A. E. Forstall, Montclair, N. J.
Members of Council (two years)—I. C. Baxter, A. S. Miller, E. H. Jenkins, C. F. Prichard.

Mr. Crockett subsequently acknowledged his indebtedness by telegraph from San Francisco, while Messrs. Humphreys, Ramsdell, Pratt and Forstall made theirs in person. Next came the paper, by Mr. Paul Doty, which was "A Report on Burner Stoppages," and it led to a lively discussion, into which Mr. S. F. Hayward injected quite a bit of humor. Mr. F. H. Shelton's paper on "A Quadruplex Purifying Box: Why Not?" provoked a spirited debate. A slight dip into the Question Box, with the resultant query and answer, brought the first day's technical proceedings to an end. Even though the Association was "very far from Broadway," the hours between adjournment and reconvening for the second day's sessions lacked nothing from any point of view; an informal reception and dance in the Chamberlin's beautiful ball room annex being a feature—and a decidedly enjoyable one—of the evening's doings. The paper by Mr. F. B. Wheeler, on "Rust in House Pipes," introduced the technical business of the second day. It was followed by an addition to the set list, in the shape of a paper, by Mr. W. R. Beal, of New York, whose description of "Novel Purifiers" was a fit supplement to Mr. Shelton's earlier "Quadruplex" theory. The Association having selected another watering place (Niagara Falls, N. Y.) as the spot for the meeting of 1898, Mr. Alten S. Miller reported on behalf of the Committee on Research. Mr. Miller, of course, is nothing if not practical, and we are sorry that the Association's rules preclude a verbatim report of that which was said and done over the reception of the Committee's findings. However, the Committee was continued, as it should have been, and with a hearty vote of thanks as well. That little-big bunch of human wire connected with 26 Broadway (Mr. C. M. Higgins), just home from a sojourn in "Old England," sent a clever message of congratulation, and 'tis "odds on" he would rather be at Fort Monroe than in "The Cecil." The "beauties" of the Association were well portrayed in a photograph, the camera eye for which was opened on the Chamberlin main front steps, right after the noon adjournment, after which fatiguing effort (luncheon was absorbed meanwhile) the ladies and others were treated to a trolley ride. At 2:30 the sessions were resumed, the opening number being the paper, by Mr. R. M. Searle, on "Gas Advertising." The next topic was in the shape of an added paper, by Mr. T. Littlehales, of Syracuse, N. Y., who presented some odd facts and figures in connection with the testing of consumers' meters; and his presentation of that never-old-always-new topic caused many of the old-timers to smile. Next in order was the paper, by Mr. Alten S. Miller, who narrated "Some Further Experiments in Interior Illumination." The discussion on this paper, unfortunately, was all too short, for there was much in it that would lead to differing thought. The discussion on the Miller paper was followed by an examination and sifting of the contents of the Question Box, after which came a well put short topic statement, by Mr. J. M. Rusby, of Jersey City, N. J., on the matter of "Leakage." In the absence of Mr. Rusby, his lines were read by the Secretary. The usual votes of thanks followed, and at this hour (5:30 P.M.) everyone is getting ready for the banquet.—C.

FORT MONROE, Oct. 22, 1897.

Dear JOURNAL: The banquet of last night was a success in every sense, 141 participating in its harmonies. Captain White acted as Toastmaster. The speakers responding to the set toasts were President Nettleton, Geo. T. Thompson, Wm. McDonald, M. S. Greenough, A. R. Foote, Mr. Eaton, of Philadelphia, and Chas. H. Dickey. Among the impromptu speeches those by Mr. F. H. Shelton and A. C. Wood were noteworthy. This morning, the weather conditions of which are simply glorious, all are ready to take part in the excursion over the historic waters of "these parts." The trip is to include a visit to the shipbuilding works at Newport News. The meeting was a complete success.—C.

The Automatic Regulation of the Speed of Exhausters.

[A paper read by MR. MATTHEW DUNN, of Selby, before the North of England Gas Managers' Association.]

There are few matters of greater importance to gas engineers than that of insuring a constant and equal exhaust, without which there is an excessive deposit of carbon upon the sides of the retorts, occasioning a corresponding deterioration in the quality of the gas. It is therefore felt that little excuse is required for bringing the subject of this paper before you to-day; the advantage of any appliance proved to automatically regulate the speed of exhausters when driven either by gas or steam engines being universally acknowledged. The utility of such an apparatus must be apparent to all members of the gas profession, and especially to those engineers at whose works the exhausters are driven by means of gas engines.

Before proceeding to describe the apparatus, it may be advisable to refer to a paragraph in an excellent paper entitled "The Modern Gas Engine: Its Development and Applications," prepared by Mr. G. E. Stevenson, and read before the members of the Incorporated Institution of Gas Engineers at their meeting held in May, 1895. Mr. Stevenson, with admirable lucidity, described the gas engine from its introduction, and in one of the concluding paragraphs, he said:

"Much may be done by the owners of gas works to encourage the use of gas engines by employing them for their own purposes. It is at present the exception rather than the rule to find them used in gas works. In small works, the principal thing for which power is required is driving the exhauster; but in few instances are gas engines used for that purpose—one reason being that variations of speed are difficult to provide for. It might be worth inquiry whether some convenient appliance could not be devised for varying the speed of the exhauster, while that of the engine remained constant."

Mr. Stevenson afterwards stated, in his reply on the discussion which followed, that he had seen exhausters driven by gas engines, and in every case it had been necessary to bye-pass the gas to some extent, in order to maintain equilibrium and to meet variations in the make of gas. The perusal of this paper led the author to experiment, in conjunction with a colleague, with the view of finding a solution of the problem. For this purpose, models were prepared and many experiments made; but it was not until March of this year that the peculiar conditions required were actually fulfilled.

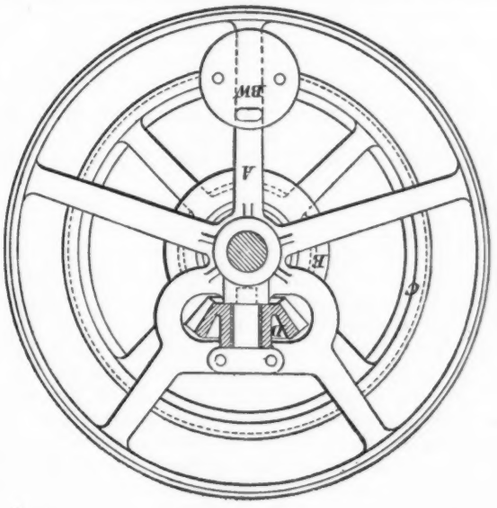
Early in May last a full size apparatus was fixed to an exhauster at the Selby Gas Works, which has continued "automatically regulating the speed" from that time down to the present day, according to the variations in the make of gas and the fluctuations in the speed of the engine—and this without the usual bye-passing. The exhauster is alternately driven by means of a gas and steam engine; and in both cases the apparatus acts with perfect regularity, and maintains a steady gauge throughout, as indicated by the eleven pressure diagrams shown.

[The author here exhibited a series of eleven diagrams. Diagram No. 1 showed the working with the gas engine taken immediately after the apparatus was fixed; No. 2 was an indication of the working with the steam engine, taken at about the same time, but after sundry alterations had been made, principally with the object of reducing friction at the several working parts. He explained that much improvement had been effected, as diagrams Nos. 3 and 4 proved; the former with a gas engine, and the latter with steam driving.]

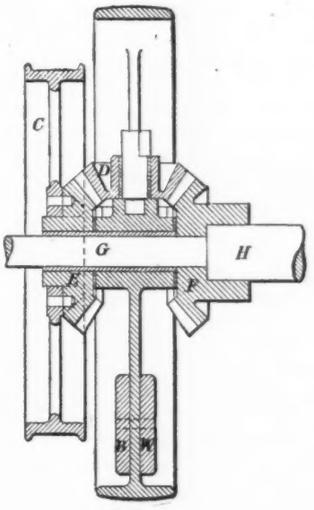
At present, the only way, apart from bye-passing, of regulating the speed of exhausters with any degree of success, is by attaching a governor to a throttle or equilibrium valve, which regulates the steam supply to the engine. This system does not appear to be altogether satisfactory for the following reasons:

1. No matter how sensitive the action of the equilibrium or throttle valve, it is still dealing with expansive steam. Even though the valve be shut off entirely, the live steam contained in the pipes, cylinder and ports will expand and continue to exert a certain amount of power upon the engine, impeding the desired rapid reduction of speed.

2. In a large works, the engine may often be used to drive two exhausters in winter, when both are required; while in midsummer only one will be necessary, and that probably running slow. In such circumstances, the governing arrangement that will suit the former set of conditions will not do for the latter, and will be difficult of readjustment. It is almost impossible to proportion the size of an engine in a gas works to the work it has to do, on account of the fluctuating character of that work; and, as a natural consequence, it is difficult to properly govern the exhauster all the year round. For small or medium sized works, where the engine may be required to do several other duties—such as driving pumps, rotary washers, coke breakers,



Elevation of Wheel.



Section.

etc.—the engine is usually made larger to permit of its overtaking the extra work, which is of an intermittent character. Having regard also to the great difference between summer and winter production of gas, the possible change in the number of exhausters at work, and the variations of boiler pressure, the difficulty of obtaining a steady gauge by the steam regulator is manifest.

[The author illustrated this point by the other diagrams of the series—taken from a steam regulated exhauster by an engineer in the Midlands. He remarked that diagram No. 5 was very regular throughout the 24 hours, and was taken with 40 retorts in operation. No. 6 was taken with 32 retorts in action, and was fairly good, though not so regular as No. 5. No. 7 was irregular, and was taken with 24 retorts on. Nos. 8, 9, 10 and 11 were much worse, and showed the working with 16 retorts. In another instance, diagrams obtained from an important works showed variations as much as 2 inches in the pull on the retorts during charging periods—and this, too, with an engine supposed to be controlled by means of a steam regulator. From the foregoing, and many similar cases which might be mentioned, the author thought it was evident that the steam regulator was not universally successful.]

When we come to the gas engine as the motive power for our exhausters and machinery, we have a motor the speed of which is practically constant, to drive an apparatus the speed of which is ever varying; and this, in the ordinary course, necessitates much bye-passing, which combines with the usual periodical rearrangement of pulleys to prevent in a great measure the adoption—otherwise appropriate—of the gas engine in a gas works. It is suggested that the new automatic apparatus about to be described, besides supplying the necessary correcting medium in the case of gas exhausters driven by gas engines, is equally applicable to exhausters where steam engines are used, and where the difficulties of obtaining a steady gauge are considerable.

When the gas engine for driving the exhauster was adopted at Selby in 1895, it was at once realized that there were many accompanying difficulties. In order to maintain a steady gauge, much bye-passing had to be done; and more frequent attention was required than hitherto. However, by the use of the apparatus which is to be described, highly satisfactory results have been produced, and the attention needed almost reduced to *nil*—and this with what may be considered only an experimental set, temporarily fixed, and in every way too heavy and unlike the latest type.

The principle of its action can be seen from the illustration, as well as from a working model now shown. One side of the gear is connected to the motor, either directly or by a belt; and the other is connected to the exhauster. Between the two is the brake or resistance wheel *C*, fixed on the boss of the wheel *E*, the speed of both being controlled by the governor bell. A driving pulley *A B* is provided, upon the arm of which is pivoted, in a suitable bearing, a bevel or miter wheel *D*, which, it will be noticed, is in gear with the two miter wheels *E* and *F* fitted upon the horizontal shafts *G* and *H*. The miter wheel *F* is fixed and keyed at the end of the shaft *H*. Butted thereto, and loose in *F*, a smaller shaft is continued through the several wheels, and is supported at the end by means of a suitable bearing or pedestal. These two shafts only meet in the boss of the wheel *F*, and are otherwise entirely independent of each other.

A band brake is arranged partially around the lower side of the brake pulley *C*, and a brake lever carried in a suitable bracket is connected to one end of the band brake—the other end being carried by a fixed bracket. On the brake lever end a cord or wire is attached, which is carried over small guide pulleys and fastened to the center of the governor bell, which, of course, rises and falls according to the pressure in the mains leading from the retorts. In this way the variations of pressure in the retort mains are automatically placed in direct control of the speed of the exhauster. To illustrate this, two extreme cases may be taken, in both of which the engine is kept running at the same speed. Supposing the exhauster to be not required, and standing still, the governor bell will be down, removing all strain from the brake lever. The wheel *A B* and the two pinions *E* and *D* being thus thrown loose, are merely revolving and absorbing no more power than the loose pulley familiar to all with shop experience. On the other hand, let it be supposed the exhauster is required to run at its maximum speed. The brake wheel will then be restrained from turning, or braked down, by reason of its having a full load thrown upon it by the governor. It is apparent, therefore, that the brake wheel is really a resistance wheel, and takes up the motive power otherwise used by the exhauster when that is not working, and when held or braked down by the action of the governor conversely transfers the motive power to the exhauster. In ordinary working the circumstances will vary between the two extremes above cited, and the apparatus can therefore work the exhauster at any speed up to the maximum rate. The rate of speed being always regulated according to the make of gas, by the governor's control of the brake wheel, it is impossible for the exhauster to exert a greater pull on the retorts than the set amount, as the connection between the governor and the gear is regular, and the exhauster is accelerated or retarded in a direct and positive manner. The pull on the retorts can be so regulated by adding weights to the end of the brake lever that any required maximum pull can be fixed upon up to the maximum capacity of the gear.

Comparing the action of this apparatus with that of the bye-passing arrangement, it will be seen that the former goes to the root of the matter, and alters the speed of the exhauster according to the make of gas automatically, instead of merely churning a portion of the gas over and over again. With the bye-pass it is necessary, in order to deal with the maximum make, to run an exhauster too fast for the periods of minimum production, and allow so much to leak by. It would be interesting to know the number of revolutions in excess of actual requirements made by the average exhauster in, say, a year's working, where bye-passing is entirely relied upon. There is no doubt this would be found by no means insignificant. This excess must have an important bearing on the efficient working of the engine and exhauster, and the length of time that they will run smooth and tight, while the extra lubrication and attention required will be considerable.

Having described the working of the apparatus, the author would urge his professional brethren present to examine and test the model before them, which will fully demonstrate all that has been said in the course of the paper with reference to the appliance and its working.

Before concluding, it may not be out of place to refer to previous attempts made in the same direction. First, reference may be made to the Fison apparatus, which consists in driving the exhauster by means of a belt running on cone pulleys, one of which is fixed on the exhaus-

ter shaft, and the other on a countershaft or on the engine shaft. The variation is effected by attaching the belt fork or guide to the exhauster governor, which directs the belt up or down the cones. It need hardly be mentioned that this apparatus, on account of the power required to move the belt to and fro on the cones, and the tendency of belts to climb to the highest part of a pulley—resulting in belt breaking, etc.—has not met with the success anticipated. Another plan referred to by Mr. Stevenson, on the date previously mentioned, is an ingenious arrangement consisting of a disc, having a small wheel fixed, and working on the face thereof at right angles. The two work together by means of friction, the variation of speed being effected by changing the position of the small horizontal wheel from the center to the circumference of the disc, and vice versa. There may be many applications of this clever contrivance, but as yet the author is not aware that it has been adopted, or is in any way suited to the purpose.

In any apparatus for this object, it must be borne in mind that the power available for operating it is very small, from the fact that the effective power given off by the governor is little. The apparatus, however, which is being brought under your notice to-day requires little power to operate it—no more, in fact, than that needed to work an ordinary bye-pass or steam regulating valve. It is very sensitive to the least perceptible variation, as will be noted in the manipulation of the working model, which practically explains itself, and will save any further detailed description of its construction.

In conclusion, the following summary of the advantages of the gear may be given :

1. A steadier gauge can be maintained, as indicated by the pressure register.
2. A more uniform effect is exerted on the illuminating power of the gas.
3. The suction on the retorts being constant, there is much less formation of carbon within.
4. Owing to the reduction in wear and tear, the life of the exhauster is longer, and less lubrication and attention are required.
5. The apparatus is suitable alike for gas or steam driven exhausters.
6. One engine can drive two or more exhausters at different speeds.
7. The exhauster can be stopped or started independently of the engine.
8. The gear is applicable either to direct-driven or belt-driven exhausters.
9. It furnishes a method quicker in action and more sensitive than that of governing the engine.
10. It is simple, durable and absolutely reliable.

Discussion.

The President said they had just heard read a paper which was full of interesting and suggestive points ; and he hoped that the discussion would be full and free.

Mr. David Terrace (Middlesbrough) was sure they were all indebted to Mr. Dunn for giving them so interesting a paper. There was no doubt whatever he was working in the right direction—that was to say, that an engine, to be a real engine to be used in the driving of exhausters, should run at a uniform speed, and give off its proper duty at the same time. But he (Mr. Terrace) could scarcely agree with the author in his conclusion that the apparatus would be more economical than the present means which were used, because, with Mr. Dunn's apparatus, the engine would necessarily have to run at its full speed all the time, although the exhauster would not, and the wear and tear of the engine would go on all the time. It was only in the exhauster that the wear and tear would be reduced. At the same time, he (Mr. Terrace) thought it was an admirable contrivance. He tried, while Mr. Dunn was speaking, to get at the principle of its action ; but he confessed that up to the present moment he had failed to see how it acted. Perhaps Mr. Dunn would enlighten them as to what made him think of this method of arriving at the result he had achieved.

Mr. E. H. Millard (Durham) said that there were one or two points upon which he should like elucidation. One was as to the point where the pressures shown on the diagrams were taken, as they knew that the position made a very great difference. If they were close to the exhauster, they knew they would get considerable more variation than they would further back, nearer to the retorts. There was also the common device of checking the tap a little, so as to prevent oscillation. He should like to know how far this might apply to the diagrams. The apparatus was certainly a very ingenious adaptation. But it was nothing more nor less than the differential dynamometer applied to the speed of the engine ; and it was bound to act. It was only strange that when they had the dynamometer, nobody ever saw its application to the driving of exhausters. The diagrams shown were certainly excellent. One could tell almost every retort as it was put on, and there was a considerable difference where this apparatus was employed, and where the ordinary arrangement was used. Anyone could see that. He could congratulate Mr. Dunn upon his maiden effort, and he hoped this would not be the last paper the Association would have from him.

Mr. T. Bower (West Hartlepool) said they were all much indebted, he was sure, to Mr. Dunn for the able paper he had put before them, and for the experiments he had shown them with reference to a matter which was of very great importance to all gas managers. If the old maxim were correct, that dividends were made in the retort house—and to his mind it was a true one—the apparatus which had been put before them, if further practice established that it would answer all that was claimed for it, would, he was sure, conduce very much to the enhancing of the dividends of gas companies. The matter of gas exhausting was at all times rather a delicate one, and at the present time he was having an experience, which, he was sure, was one which many managers had had who were in the habit of working two retort houses with one exhauster. In the case of No. 1 house, he had a very long length of foul main ; and in the case of No. 2 house, a very much shorter one. In fact, the areas of the two were almost as entirely different as the circumstances would entitle them to think of. The result was that, let them be never so careful in regulating the speed of the exhauster, they were bound to have a variation in the pressure. He mentioned this more particularly as he thought it might be information to Mr. Dunn, if it had not come under his observation before, and because, if his apparatus should be found to be suitable for such a state of matters as he (Mr. Bower) had named, it would be very readily taken up by those who had to work two retort houses with one exhauster. The results shown in the diagrams seemed to be exceedingly even ; but, of course, it would be a great factor as to the accuracy of the diagrams if the points they were taken from were given. The apparatus, looking at it on the spur of the moment, seemed to be one that there should be no difficulty whatever in getting to work directly; and as the author had described, of course, it was one of those appliances of which he could imagine they would require to have a litttle experience before they could speak with any amount of confidence upon it. Mr. Dunn had had more experience with it than anyone else, and naturally he might take a sanguine view of its capabilities. He had no doubt that, if further trial strengthened the points Mr. Dunn had put before them, there was a field for the apparatus, and that it would push its way into gas works.

Mr. Herbert Lees (Hexham) joined with the previous speakers in their thanks to Mr. Dunn for having brought the subject before them. The question of exhausting was one which was always of importance in gas works. As Mr. Dunn proceeded with the reading of his paper, the difficulty with him (Mr. Lees) was as to where the advantage was to come in. However, before they got to the end of the paper, it was shown that the main advantage claimed was better regulation, and saving in wear and tear of the exhauster. He did not know what the latter might amount to; but he was anticipating that there would be more saving in the case of steam, because if with gas the engine was kept running at the same rate of speed, and the brake was put upon the exhauster, there would be no saving whatever. It would also have been, perhaps, a more reliable test of the apparatus if the diagrams exhibited had been taken from the same exhauster before and after the application of the apparatus. He understood that this was not done ; but that the diagrams taken from the exhauster without the apparatus were from a different exhauster to the one to which the apparatus had since been applied. He was not quite sure that the practice of bye-passing was such a detrimental one. Of course, he was open to conviction upon this point, as well as upon other subjects which might be brought before them ; but what was the depreciation which the gas suffered from bye-passing ? Did the gas suffer in consequence, and if so, how much ? There was certainly no economy in the working of the engine which Mr. Dunn had shown them ; and he (Mr. Lees) failed to see any very great advantage which there would be in introducing the appliance. He thought it was quite possible to work with a bye-pass with a very little variation in the exhaust, or a vacuum ; and unless there were some very clear indication that it would be a gain in some other way, it was probable that the apparatus would not be generally adopted. However, the proposal was in its initial stage. He thought that Mr. Dunn was working in the right direction ; and he was quite sure that the subject was in good hands, and that if any improvement were to be effected by it, they would hear from him about it, and they would all get the benefit of his experience in the matter.

Mr. W. D. Gibb (Newcastle) said his great objection to the apparatus was that he did not see why the gas engine was introduced at all. The steam engine, to his mind, seemed to be a more simple and a better way of governing the speed of exhausters, which, at all times, must vary. To start with, they must have an engine which was capable of doing the maximum amount of work; and then they required an engine which could be regulated to do a less amount of work. In the steam engine, they could easily regulate this by the amount of steam introduced, and further by expansion gear. If the gas engine were used, then, as Mr. Lees had said, it would be running at full power throughout; but he failed to see the force of Mr. Lees' argument that, by bye passing the gas, he saved a part of the energy expended by the engine. In his opinion, bye-passing did not save in the actual amount of energy required to move the gas. But the apparatus shown, so far as he could understand it, was certainly a most ingenious one. He was really not competent to prophesy as to its future; but they were all very much indebted to Mr. Dunn for bringing it forward. Gas exhausting was always a most interesting subject to gas managers, as well as a most fascinating one to most of them.

Mr. R. Porter (Elland), on being invited as a visitor to express his opinion, said he was not very favorably impressed with what the commercial result of the arrangement might be. He had had some experience with gas engines for driving exhausters. He had had five years' experience, almost to a day, with one, without having any steam engine as an auxiliary; and he was not very favorably impressed with the idea of using gas engines for the purpose. He did not think they were so cheap as steam engines, because the fuel which they used in a gas works for producing steam was of a very cheap quality, and they might even have to pay for carting it away if they did not use it for the purpose. Consequently he thought that steam was preferable for driving exhausters; and further, he thought it could be more economically applied to exhausters, because they could regulate the speed of the engine as well as that of the exhauster. He did not think they would gain a very great advantage by altering the speed of the exhauster, if they could not alter the speed of the engine, and thereby conserve some of the energy required for driving it. Steam was governed, and consequently the wear and tear with it must be less.

Mr. B. B. Waller (London) thought the apparatus which had been brought forward by Mr. Dunn showed a great deal of ingenuity. He considered it would be an excellent means of doing the work; but, as had been said, it did not affect the speed of the gas engine. If they could regulate this, and thereby save gas, it was a point which should be studied. For the governing of steam engines, he thought personally that a governor acting directly upon the steam valve was what should be used. The nearer they got the source of governing to the steam inlet, the better governing result they obtained. As far as gas engines were concerned, they generally only found them in connection with minor works, where a small exhauster was used. The difference between the maximum and minimum make in such works was so trifling a factor that bye-passing was of little moment. The apparatus shown was a very great step in the right direction in the matter of governing an exhauster driven by gas. He thought it was an excellent arrangement, and a great advance beyond the old regulator used for governing an exhauster that was driven by a gas engine, and a vast improvement upon it.

Mr. H. Tobey (Malton) said he must compliment Mr. Dunn upon the able manner in which he had laid the matter before the meeting, and especially for the working model he had shown. He thought the apparatus was much more suitable—and possibly Mr. Dunn had this in mind when he designed it—for small than for large works. As they knew, in the latter works they kept a man to attend to the exhauster; but in works of limited capacity this business had to be attended to by a stoker, who had also other occupation. In such a case, he thought that a gas engine was admirably fitted for driving an exhauster; and any method which would enable them to regulate the speed of the exhauster should commend itself to all as being suitable for small works. He himself hardly thought the apparatus was qualified to take the place of the ordinary regulation by means of bye-passing. But it appeared to him that they had here the gas engine, the exhauster and the governor, the same as in an ordinary case; but they had, in addition, the gearing of the apparatus for regulating the speed of the exhauster. This gearing stopped the motion, and therefore it was liable to get out of order, and required to be attended to and kept in repair. On the other hand, in the ordinary governor and bye pass, they had a very simple arrangement. There was little also in its first cost, and it was very efficient if they had the governor large enough. It was very easily adjusted so as to give a constant pull on the retorts; and there was very little variation with it, either up or down, on the gauge. Therefore he hardly thought the apparatus was likely to come into ordinary use. Something was said about gas engines for driving exhausters having always to go at one speed. But the speed of these engines could be varied from 200 to perhaps 140 revolutions. This was a range within which they could be run very efficiently. In addition to this, in small works they could always make a change of wheels upon the engine. If they started an extra bed of retorts, they could put a larger wheel on the engine and a smaller one on the exhauster. It would not take a day to change the wheels, and with the change they would be able to meet the requirements of small works very satisfactorily. As he had said, they were obliged to Mr. Dunn for bringing this matter before them; but, at the same time, it did not commend itself to his mind as being any very great advance upon what they already had.

Mr. C. D. Drury (Hendon, Sunderland) said that he agreed more or less with Mr. Gibb that, especially in large works, there was no reason why gas should be substituted for steam, except by way of example to consumers, to induce them to take up gas engines. In gas works there was such a large quantity of refuse fuel that was worth using up in the way of raising steam, for which it was very cheap. They always required steam in gas works, and, therefore, except as he had said, by way of example to those outside, he did not see any reason for substituting gas.

Mr. W. Ford (Stockton) said he had only one question to ask, and that was whether Mr. Dunn worked his retorts on Sundays; and if he did not, whether he found that the machine was of use in lowering the whole of his retorts for non-Sunday duty.

Mr. Dunn, in closing the discussion, said that Mr. Terrace had asked him how he first obtained the notion of this apparatus. Well, he might cause a smile, but he got the idea first of all from an old tricycle. If they examined the gear box of an old tricycle they would see very much of the idea. Mr. Millard asked at what point he took the pressure. It was taken within 6 feet of the inlet to the exhauster, and at this place he thought they got as fair a test as possible.

Mr. Millard—What is the length of your foul main?

Mr. Dunn said it was about 120 feet. As regarded the doctoring of the taps, he might say they were all of ordinary type, clean, and of full size. With reference to Mr. Bower's case in point, he did not know how he would apply his apparatus, but he desired specially to show them that it could be applied to steam engines equally as well as to gas engines, as the indicator diagrams would show. There seemed to be a mistaken idea with reference to the subject of wear and tear on the engine. He could demonstrate to anyone present that with the apparatus he could release the brake or brake the speed down, but it did not take the load off the engine. It varied the speed of the exhauster, and it would do this with a steam engine as well as with a gas engine. He had tested it, because he knew it was one of the points which would be raised; and he found that, when they took the brake off, when they took the load off, they put it upon the apparatus to act, and there were fewer explosions. If they put more work on a gas engine, and found that the explosions became more frequent, this apparatus would take hold of it. That also answered Mr. Potter's query. They must not mistake him; he was not there to advocate the adoption of the gas engine in all cases. He adopted the gas engine more for convenience than anything else. He had at one time a steam engine, which had been built "in the time of Adam;" it was subject to fits, and he wanted something which he could rush to and set to work at once, because he had only limited storage and could not allow the exhauster to stand a minute. He pitched upon a gas engine as a remedy, and he had never seen any disadvantage in using such an engine. Nay, at all times, he used it in preference to steam; but when he wanted steam, he would put it in for a week or so, and thereby use up all his refuse ashes and the like. But the gearing was not, and was not intended to be, applicable to gas solely, but was brought into use to get himself out of a difficulty, because he found out that there had been an extraordinary amount of bye-passing going on. The gas engine required very little attention. Indeed, after charging, the men could go away happy and enjoy their supper. If they watched the machine, as some had done in his place, it was wonderful how it acted; it soon got abreast of its work. It ran perfectly smoothly; and they could always tell by the checking of the wheels, and the action of the brake, if there was trouble ahead. Mr. Waller seemed to have the same idea as Mr. Porter, as to the machine; but if they took it to pieces and saw how it was put together, they would appreciate it in a moment. It was not complicated; it was very simple in every way. Mr. Tobey did not seem to fall in with the idea of the apparatus, but he (Mr. Dunn) knew that he had a plain duty, and that duty was to do all that he could to

further the interests of the Association. He thought, therefore, that by bringing forward this thing, no matter although it was small and insignificant, it was a step in the right direction. He was prepared to be criticized, but he would say this—that, having tried the apparatus for five months, he was perfectly satisfied that it was not to be laid by. And they would find that it was a notion which would be applicable to the regulation of other things—such, for instance, in electric motors, checking off the spent energy. It would also be applicable to machines both pneumatic and hydraulic. He had tested it in every possible way, and when any gentleman had come to his place he had put himself to any trouble, purposely to give it a chance of making a mistake. It had, however, never done so yet. He could say this, that in large or small works it was bound to come into use. There was no doubt about its acting promptly, because the moment the governor acted in the slightest degree, the motion was transferred to the check wheel, and the check went on. Mr. Drury referred to large works. Unfortunately he had had no experience in large works, but he trusted it was not thought there that gas engines were not worthy of encouragement. He knew that the apparatus was much finer in its work than the steam regulating valve, because he had seen it and tested it, under various conditions. As to Mr. Ford's question, in summer he worked his stokers six days a week. He put them off on the Sunday, and damped down. In winter they worked seven days a week, but if he were to slack the whole of his retort lids at a given moment, they would come to a standstill, but the engine would be working all the time.

Mr. W. Hardie, Jr. (Tynemouth), proposed a hearty vote of thanks to the President and to Mr. Dunn. They had, he said, all looked forward to the meeting at Scarborough for some time. They knew they would have a successful gathering, and he thought that the meeting they had had had well repaid them all for the trouble they had taken in coming to it. Mr. Holliday's address was brimful of up-to-date matter, which, he thought, would be a positive help to the great majority of the members of the Association, and to the gas industry generally. The paper they had had from Mr. Dunn was also, he thought, one which stood very well in order, as regarded a paper. The subject was thoroughly well chosen. It was a most interesting matter, and there could be no doubt from the way in which the mechanical contrivance shown had worked, that it was one of the most beautiful things they had had put before them for many a day. There seemed no doubt that the machine was capable of performing what it professed to do. Whether it did it better than the ordinary gas main bye-pass and the ordinary steam throttle remained to be seen. A great many of them had worked with both appliances. He need scarcely say that he had seen diagrams better than those which had been shown to them. Working with this apparatus, a diagram could be kept constant, day after day, and week after week ; and he thought that was a very good thing. Steam throttle valves did sometimes stick, and they were then very troublesome. As regarded gas engines—well, they did not all like to churn their gas over again. He might say that he had the pleasure of going to the gas works at Scarborough that morning, and he was much struck with the diagrams that Mr. Holliday had on his register. It would be very difficult to beat them ; and as far as he (Mr. Hardie) could see, the results were obtained neither by an arrangement of the sort shown nor by a steam throttle valve. Mr. Holliday seemed to have some special arrangement of his own. But he thought that, perhaps, the getting of a nice diagram was not altogether dependent upon the throttle valve ; it was, to some extent, dependent upon the field they had to run upon, in their hydraulic main, or something of that sort.

Mr. Bower said he had great pleasure indeed in seconding the motion, and also in supporting the remarks which the proposer had made. Some of them who had been members of the Association for many years, expected great things of the President, and they had not been disappointed. He (Mr. Bower) was quite sure the dignity of the Association would be maintained throughout the coming year. He believed Mr. Holliday had the distinction of being the youngest President of the Association ; and, if for no other reason, he thought he deserved their heartiest thanks. The fact that he had undertaken the duties of President at such an early stage in his career, entitled him to their cordial approval. With regard to Mr. Dunn, as he had said before, they were much indebted to him for the matter he had put before them. No doubt many would think more carefully over the matter than they had had the opportunity of doing that morning. They were reminded of what their friend Mr. Ford had so often told the Association—that the young men were not following the old men ; and therefore he was especially pleased that Mr. Dunn—a young member of the Association—had come forward and given them so excellent a paper.

The President said he was extremely obliged to them for their kindness, and for the manner in which the vote of thanks had been put before them. In regard to Mr. Dunn's paper, he thought it was a really admirable production, and one upon which he deserved a great amount of congratulation. The idea of employing gas engines in gas works was the right line to follow, if they wanted to introduce gas engines into other places. With regard to the point about fuel, he did not know that it mattered a great deal whether they were using the fuel on the spot, or were using gas ; they were both there to be used. But if they wanted to encourage the use of gas engines, there was no doubt about it that the right way was to use them themselves, and thereby let other people see that they had confidence in them. The idea of Mr. Dunn's apparatus was a good one, and he believed, as Mr. Dunn had told them, that it would apply to other plant as well as to gas engines. He hoped that Mr. Dunn's ingenuity in devising this thing would be rewarded in the future.

Mr. Dunn, in acknowledging the vote of thanks to him, said he was very much indebted indeed to Mr. Hardie and Mr. Bower for the kind manner in which his name had been mentioned. It was very encouraging to a young member of the Association to come forward. Their vote of thanks to him would act as a stimulus to all the young members. He chose the subject he did because he had been experimenting with it for some years, and was more at home in it than in any other.

On an Improvement in the Art of Galvanizing.

[Read by Mr. George C. Reese, before the Franklin Institute.]

The object of this paper is to call attention to a recent advance in the art of galvanizing, by which many objectionable features are obviated, which have heretofore characterized the methods of manufacturing generally in use, thereby insuring not only greater rapidity of production, better quality of product, economy in fuel, labor, capital, interest and other charges, but also resulting in the production of new forms of galvanized wire or coated material heretofore unknown to the trade.

For certain special uses of iron and steel, it is desirable, in many cases, to give the metal a coating which will be a protection from oxidation, and at the same time facilitate the uniting of different parts by soldering the coatings together. This is effected by immersing the iron, after it has been properly cleansed and prepared, in a bath of molten zinc, whereby a coating of zinc is obtained which firmly adheres to the iron, by reason of the alloying action between the two metals. This operation is universally known as galvanizing (which, it may be remarked incidentally, is a misnomer), and differs very little from tinning and lead coating.

The protection from oxidation, in galvanized wire, is fully accomplished when a very thin and uniform coating is obtained, but where the wire is afterwards to be subjected to twisting and bending, such as twisting the ends of telegraph wires together, or the weaving of wire cloth, the wire should be soft and the zinc as pure as possible, so that the elongation of the two metals is as nearly equal as possible, otherwise the coating is liable to crack and peel off.

In galvanizing it is necessary that the iron operated on should remain in the bath until it acquires the same temperature as the molten metal, or the coating will not adhere ; this, in the case of galvanized wire, necessitates the maintenance of large tanks of molten zinc, containing often as much as 50 to 60 tons of metal.

In the usual method as heretofore practiced, a number of previously prepared wires are drawn slowly through the molten bath of coating metal, and, upon emerging therefrom, are passed through tightly enveloping wipers of asbestos or other material to remove the excess of coating upon their surfaces. This method is necessarily slow, because the time of transit through the bath is fixed by the fact that the temperature of the wire must be raised to, or approximately to, that of the spelter in order that it may receive a thin, durable coating ; and also because of the frequent breakage of the wires from the tension exerted upon them by the action of the drawing and reeling devices.

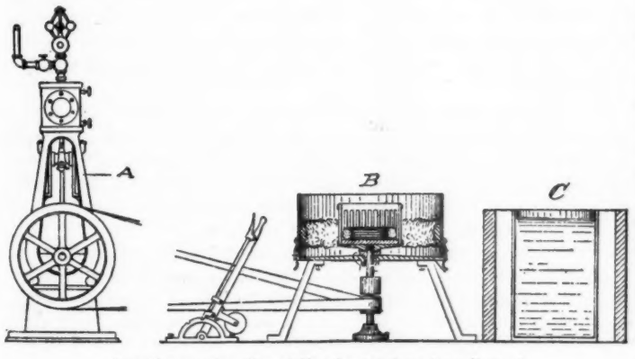
The speed at which No. 12 wire is coated being from about 50 to 60 feet per minute, this gauge runs from ¼ to ½ mile, and smaller gauges several miles in length, per bundle. Hence, although many devices have been adopted for increasing the production and decreasing the breakage, by complicated apparatus for drawing larger numbers of wires through the bath and the wipers, and by giving notice of undue strain exerted upon the wires by tension, the output of each bath was and necessarily will be low, in the use of this old method. This in itself called for the use of a large number of galvanizing pots in order to bring up the output of the factory to the paying point. Any in-

crease in the speed of drawing inevitably requiring a corresponding increase in the length of the pots because the time of transit through the bath could not be shortened below the limit before mentioned.

The constant maintenance of an enormous tonnage of spelter in a fluid condition, constantly exposed to oxidation and to the destructive alloying action of the metallic surfaces of the pots, entailed great loss, trouble and annoyance by the rapid formation of "dross" and oxides. The percentage of dross should be kept as low as possible to insure proper fluidity and working of the bath. This dross consists mainly of spelter, which granulates after alloying with a very small percentage of iron, and, being heavier than the pure spelter, sinks to the bottom of the bath. Its formation, in conjunction with the necessity of drawing the wires slowly through long, deep, wide baths, has entailed great loss.

It will be seen, therefore, that the method of drawing wire through a bath and wipers is radically defective in its principle of operation, of progressively subjecting succeeding portions of the coating to the action of the wipers by tension, apart from any defects in apparatus used for such purpose; yet, notwithstanding, it has continued in use as the only practical method heretofore known to the art for giving a good and reasonably uniform coating to ordinary or fine wire.

By a newly patented method, the practicability of which has been demonstrated at the works of the Sharon Hill Galvanizing Company, Darby, Pa., the samples of coated wire which are now exhibited for your inspection are some of the many forms in which wire can be coated in a cheap, rapid and efficient manner, at a speed heretofore impossible to attain, and of a quality, uniformity and finish of coating unequalled by that of the wiping process. This is done by a method of operation which absolutely prevents the breakage by tension and the imperfect ends which occur in the wiping method; it obviates also the necessity of keeping a large tonnage of spelter constantly heated and exposed to the formation of dross by alloying and oxidation, reduces investment, capital, interest, fuel, labor and other incidental charges, and enables the manufacturer, with a small cheap plant, to exceed the output of the large costly plants now in use. The securing of these results is obtained by a radical departure from the principle of operation of the old wiping method of progressively applying tractive force to successive parts of the wire or bundles; and in lieu thereof each and every part of the coating upon the wire is simultaneously subjected to the action of a centrifugal strain greater than the combined adhesive and capillary attraction acting to retain the superfluous material upon the surface of the wire or between the strands of the bundle, thereby leaving a smooth, flexible, adherent and uniform coating upon the surface of the product. This is effected by means of an apparatus shown herewith, in which *A* represents the motive power, *B* a centrifugal separator, which is generally known as a hydro-extractor, and *C* the galvanizing bath.



A, motive power; *B*, centrifugal separator; *C*, spelter pot.

The coils or bundles of wire are cleansed by acid and prepared in the usual manner to receive their coating. A whole bundle is then dipped into the bath of melted spelter, and when it has received a thorough coating, it is removed to, and dropped into the centrifugal separator, which may be in motion for small light coils, or the machine may be started after heavy bundles are placed in it. After a short space of time the wire attains the same speed as the machine, and the surplus coating is almost instantly thrown off against the safety shield. The machine is then stopped and the bundle removed. This part of the process is performed as quickly as possible, in order that none of the coating may solidify until after its removal from the machine.

The wire is then subjected to an operation designed to prevent the strands from becoming welded together when such solidification takes place. This is accomplished by jarring the bundle on a block to keep the different strands in motion or separated from each other, or by unwinding the bundle and rewinding it in such a manner that the coating may solidify while in transit from the unwinding to the rewinding reels.

In practice it has been found that a speed of 750 revolutions per minute is sufficiently high to do good work on No. 20 wire in bundles of 10 inches diameter. Larger gauges require less speed, on account of retaining the heat longer and because less capillary attraction is exerted where the spaces between the wires are greater; variation of the initial heat of the bath also causes variation in the cohesive force of the spelter, and variation of the chemical constituents of the bath is also a factor, as some baths work more fluid than others at a given temperature. Smaller gauges of wire and smaller bundles also call for an increased speed of rotation; but in general, I have found that the minimum and maximum speeds of rotation required, are about 500 and 1,500 revolutions per minute when operating on 10-inch bundles.

The chief advantages of this method are as follows: As it is only necessary to subject an entire bundle of wire for a few seconds of time to the action of the centrifugal separator instead of drawing a small number of strands through wipers at the slow speed of not more than 1 foot per second, as in the old wiping process, the bundles are finished as fast as they can be raised to the proper temperature and coated in the galvanizing bath, hence the tonnage output, per pot, is enormously increased, especially so on fine wires, some of which are many thousands of feet in length to the single pound, and which could not be made for general consumption on account of the prohibitive price of such galvanized product. The great increase of product from each pot renders few of them necessary in plants of large tonnage capacity, thereby saving a large proportion of the first cost, cost of repairs, fuel and labor. As few and comparatively small pots are used, but little spelter is required to be kept constantly in a molten condition, subject to continual oxidation and the formation of dross from the alloying action of the metal of the pots. The large amount of capital heretofore required to purchase and maintain in a fluid condition the enormous tonnage of spelter in comparison with the output, is not required for such purpose. Like the old wiping process, it produces a smooth, uniform, flexible coat of galvanizing material upon the wire, but has the advantage of having no breakage from tension and no waste ends on the bundles; finally, it saves capital on account of diminished labor, fuel consumption and power, concentrates the size of plant, requires less ground, fewer buildings, repairs, etc., and enables the manufacturer of galvanized wire to produce, in a cheap and rapid manner, many forms of wire heretofore unknown to the trade.

Among the new articles produced by this method is barbed wire, which has been galvanized after it has been twisted into shape and formed into bundles. When wire is galvanized before being barbed and twisted, much of the coating cracks and peels off and the points of the barbs, where they are not coated, become blunt by rusting. This new article can not only be produced much more cheaply, but is also more durable, and, as the points of the barbs are completely coated, it retains its efficiency much longer than the old kind.

Twisted fence bands are rapidly galvanized in the bundle by this method after they are formed.

The samples of wire rope here shown illustrate in a remarkable manner how perfectly the superfluous coating material may be eliminated by centrifugal action, and yet leave a perfect coating upon the wires.

Wire cloth is galvanized by the old method from 2 meshes to 8 meshes per lineal inch; but in cloth finer than 8 meshes so many of the meshes become permanently closed with the coating material that it is impossible to produce a marketable article. By the new method cloth of any fineness may be coated if the speed of rotation be increased with the fineness of the cloth operated on. I have here samples of 12×13 fly wire and No. 16 mesh, which I believe was the first cloth of this kind ever successfully galvanized after being woven.

Will the Price of Oil be Upward.

The *Petroleum Gazette* notes that Mr. Bion H. Butler, of the Pittsburg *Times* contributes to that paper a four column article, setting forth the conditions that have existed and now exist in the petroleum trade and the producing business. Mr. Butler's review covers the oil business for a number of years, noting especially the fluctuations in production, stocks, demand and prices. The belief is indicated by the tone

of the article that a climax in production has been reached, and that another upward flurry of the market may be reasonably looked for. The following extracts are full of interest:

"The thing that is difficult to determine is whether the oil trade is on the eve of another flurry that shall resemble the recovery from the depletion of stocks that culminated in 1895. In that year oil men began to realize that not only were the accumulated stocks falling away, but that the fabulous production which had been instrumental in piling up such quantities of stock had also failed. Then began the phenomenal activity in well drilling that has never before been equaled.

"With all the wells that have been drilled in the past, and with the 19,000 new ones completed since the boom of 1895 broke over the oil field, the production at the present time is barely sufficient to satisfy the demand. What is worse, the new territory to which the operator may look for production does not materialize. Old territory has been drilled carefully and thoroughly, and it is not enough.

"The world is taking American oil as fast now as it is produced, both from Appalachian fields and from the Lima fields. As the production of both sections is running over 50,000,000 barrels a year, the demand of the world for American oil is in excess of the production of any years except those of 1891, 1892, 1895 and 1896. The supply of oil having reached and passed a yield of 50,000,000 barrels a year, and the trade learned to ask for that amount, such an enormous quantity must be furnished. Were the demand unvarying at the figures that were satisfactory three or four years ago, the question of oil supply would be simplified. But with an improvement in the general business of the country the use of petroleum is bound to increase.

"What of the supply? Absolutely nothing offers at the present time except the old wells, the large number of new wells drilled in the last three years, which are merely holding the production up to the supply, and which are declining daily, and the possible trifling increase through the extension of some tolerably well defined pools like Elk Fork or the Fonner development. That is to say, that to hold the production at where it is some new pools must be found every year, and to increase the yield in proportion to the demanded increase of the past new pools and plenty of them, and good producers at that, must come to the front. It is a safe hazard to say that West Virginia alone, with the possible exception of the frontier of Pennsylvania bordering on West Virginia, holds any hope to the trade.

"The future of the oil business? Who can foretell it? To a spectator it looks as though a condition had been reached somewhat similar to that of the beginning of 1895, when the production was falling behind the supply, and while the symptoms are not so marked yet, certainly if they keep on growing the parallel will be complete. A wider demand requires a larger supply. Except for wells that are not above the average, taken together, and which have included some big ones at the start, but quitters in the long run, nothing has been found to take care of a demand that will grow if the past history of the business is an indication of the future. Many new wells are essential each year to make up for the decay of the old ones. More new ones are needed to increase the production as the increasing requirements exact. Where are 7,000 wells to be drilled next year, and the year after, and the next year? Where are more than that many wells to be drilled if the trade asks for oil in the same increasing proportion? Can the old wells meet the needs, or the new pools that may flash out in West Virginia, or Butler, or McKean? Or, can the deep sand territory? If all together can, the oil trade promises to continue very good, and to be among the foremost industries of the United States. If all these cannot supply the existing demand, and that which will come as a natural result of the growth of the industry, the same question confronts the producer that confronted him in 1895, and which for the past two years he thought he had answered. But has he?"

Electrolysis and Water Mains in Salt Lake City.

According to *Engineering Record*, in February of this year City Engineer F. C. Kelsey, of Salt Lake City, Utah, was directed to investigate reports from the Superintendent of Water Works regarding the damaging effects of electrolysis to the water mains and suggest a remedy by which the mains can be protected from this destructive influence. Mr. Kelsey's report forms the basis of a paper delivered before the Denver Convention of the American Water Works Association. He gives a number of instances which indicate as certainly as any voltmeter measurements could do that the pipes were injured by wandering electric currents.

Mr. Kelsey gives a summary of opinions regarding the indications and cause of electrolytic action and methods of determining the location. This consensus of opinions is interesting and will be valuable as bringing into a convenient form for reference a number of statements on the subject of electrolysis. It makes no mention, however, of the system of Mr. Harold P. Brown, which is different from that advised by the seven authorities whom Mr. Kelsey quotes and which is considered quite satisfactory, as it is advantageous to the railway companies. The authorities quoted and the numbers by which they are referred to by figures at the beginning of the paragraphs in the report are: 1. I. H. Farnham, Electrical Engineer, Boston, Mass.; 2. Stone & Webster, Electrical Engineers, Boston, Mass.; 3. William Jackson, City Engineer, Boston, Mass.; 4. Board of Commissioners of Electrical Subways, Brooklyn, N. Y.; 5. John A. Barrett, City Electrician, Brooklyn, N.Y.; 6. City Ordinance, Richmond, Va.; 7. G. H. Benzenberg, City Engineer, Milwaukee, Wis. Mr. Kelsey's summary is as follows:

Measurements of Currents.—(1). To locate where the pipes are in danger voltage measurements should be taken between the pipe and the damp earth immediately surrounding it; such measurements may be conducted with precision with a voltmeter and two wooden rods, in the lower ends of which are brads connected with wires leading to the voltmeter. The voltmeter is a better instrument than the ammeter for determining whether or not there is a flow of current, and the direction.

(2.) During the tests of a year ago, the greater part of our measurements which were made for the purpose of determining the potential differences were taken between the pipes or the hydrants connected with the pipes and the rails, but a careful study of the conditions convinced us that tests of this sort are unreliable and consequently all measurements made during the past year have been taken between the pipes and the earth in their immediate vicinity. The practical way in which the measurements have been made is illustrated in Plate 1 (not here shown). A rod is inserted in the hydrant box and the metallic connection upon the bottom of this rod touches the ground in the vicinity of the pipe, while the other pole of the measuring instrument is placed in contart with the metal of the hydrant, the valve stem usually being used for this purpose. In the course of the investigation some question arose as to whether the true difference of potential between a pipe and the surrounding earth is obtained by a measurement of this sort. In order to decide this question as definitely as possible, tests were made which proved conclusively that the method regularly adopted gives the correct polarity of the reading and approximately the correct value.

(3.) Measurements of similar difference of potential between water pipes and the adjacent earth are of value particularly in indicating the direction of flow of electric current rather than amount, and are not entirely reliable unless special precautions in measurements are taken. This is on account of the battery action, thermal effects and other disturbing influences.

(4.) W. Stuart Smith criticises the utterly untrustworthy and misleading results which have been obtained by some experimenters by means of ammeter readings, of which he cites a number of typical examples and gives reasons which appear conclusive for employing in his own work voltmeter readings only.

(National Board of Fire Underwriters). Whenever a reading is shown by an ordinary portable voltmeter registering tenths of a volt with the positive binding post in electrical connection with the water pipe or hydrant and the negative binding post in electrical connection with an adjacent lamp post, car track, or metal rod driven into the earth, electrical action will be found upon examination to be taking place at that point, which will ultimately result in the destruction of the water pipe.

Voltage Necessary to Produce Electrolysis and Rapidity of Action.—(1.) A fraction of volt difference of potential between pipes and the damp earth surrounding them is sufficient to induce the action. Less than one-half volt destroyed a telephone cable in a few months, the amount of current flowing is the measure of the rapidity of the action.

(2.) From investigations made by us it is obvious that an electromotive force, even so low as .002 volts, is sufficient to cause injurious action from electrolysis.

(3.) A very small difference in potential, as little as .001 of a volt, will cause electrolytic action.

(7.) It has been established in experiments by more than one investigator that it needs but an extremely low potential, not exceeding .01 of a volt, coupled with other favorable conditions, to produce electrolytic action, though it may take considerable time to cause the results to become apparent.

When Corrosion Will Take Place.—(1.) Where the pipes are positive to the earth electric currents will flow from the pipes to the earth and electrolysis is sure to result.

(2.) Experiments have shown that corrosion occurs at the places where the electric current leaves the bedded metal for the earth; there is a tendency for the metal to go to the negative pole of the generator just as in a plating battery the metal attached to the positive pole is deposited on the object attached to the negative pole.

(3.) Action of a serious nature is confined to special localities where, owing to certain conditions of the railway system, abnormal currents are flowing through the earth, but as a whole the action has been reduced to so small an amount that it is now difficult to detect.

(5.) Where the measurements at the hydrants indicate a tendency of electricity from the pipes to the earth the pipes are generally considered as liable to electrolytic corrosion.

(6.) Wherever or whenever it is shown by either a volt or ampere meter that there is any flow of electric current from the gas or water mains to the rails or along these mains, it shall be deemed sufficient proof that the said mains or pipes are liable to electric corrosion.

(7.) If the pipe at many points becomes positive to adjacent or parallel conductors, conditions will be established which will produce electrolytic action, the extent of the destructiveness of which to the pipe will depend upon the low resistance offered by the earth and upon the amount of soluble salts, the electrolysis of which is injurious to the iron that is contained therein. These salts in some one form or another are to be found to a greater or less extent in almost every street soil; and as Professor Jackson has demonstrated, only a minute quantity of soluble salt is sufficient to start action, and it will then continue as long as a current flows.

Remarks.—(1.) All single trolley railways employing the rails as a portion of the circuit cause electrolytic action and consequent corrosion of pipes in their immediate vicinity unless special provision is made to prevent it.

(2.) The results which have been obtained during the past year enable us to state quite positively that up to the present time the effect upon the pipe system as a whole has not been serious to the city of Boston, although in other places where we have conducted tests during the past year we found that rapid decay was occurring, clearly due to electrolytic action. The reason of the slight action which has been found here is primarily that the street railway system is comparatively well equipped with return wires which conduct the greater part of the current back to the power station without serious damage to the pipe system.

Pipes at points far remote from the power station in a few places were found very decidedly positive, due in some cases to the fact that the railway return circuit is not sufficiently large or is otherwise defective, and in others to the fact the piping system is not uniformly continuous in the direction of the power station, and the return current has a tendency to follow it as far as possible and then leave it for the earth. From the observations made it has been shown that the potential and the polarity of the piping system in many places are continually changing, even when the quantity of current returned remains substantially the same. This is due, first, to the degree of moisture in the soil from time to time, which affects the electrical resistance of the earth as a whole; second, to the influence of electrically poor joints in the piping system; third, to the fact that lines of piping are not continuous from all parts of the city in a direct line to the power station, on which account there is a tendency for the current to go across from one pipe to another, and the amount of current which so flows depends to a considerable extent upon the condition of the soil, which is subject to change; fourth, to the fact that the copper wires which bond the rails sometimes become corroded at the joints and affect the resistance of the return circuit, particularly where no supplementary wire is used; fifth, to the change in the return system, made by the street railway from time to time, which, even if at points from the location of hydrants tested, make considerable differences in the potential observed.

It is certain that there is injurious electrolytic action going on, and it is equally certain that this action is caused by the return currents of electric railways; there is no corrosion of this kind where there are no electric railways; the greatest trouble occurs where a large part of the return current leaves the pipes for the power station; the greater the flow of electric current from the pipes to the earth the greater the electrolytic action, and the greater number of cars on the road the greater the flow in the pipes. These facts allow no other conclusion than that the railways are the cause of electrolysis.

(3.) In certain places throughout the city electrolytic action is taking place and pipes have already been more or less injured and are subject to premature decay. The many excavations which have been made about the city for the purpose of inspecting the pipes have given only negative results, revealing no marked action and yet not proving that the natural decay has not been accelerated by electrolysis. The action at any point is liable to increase or decrease temporarily from various causes, and tests made at any one locality at any specified time give no reasonable assurance that the same condition of affairs will exist for any considerable length of time.

(4. 1896). One gratifying conclusion was arrived at as a result of this thorough examination, and that was that in the districts where underground pipes are most liable to destruction by electrolysis the cast iron water mains remain intact; the wrought iron and lead pipes deteriorate steadily and rapidly in places where cast iron shows no sign of decay. The statement in a former communication from this Board that the water system of the city was seriously endangered and probably already impaired by electrolytic corrosion now requires modification to the extent that such injury is confined to such branches as are constructed of wrought iron or lead.

The immunity from injury by the ordinary process of oxidation possessed by cast iron was long since pointed out by engineers, one of whom declared that it was his belief that the so-called white casting is practically indestructible under the action of ordinary oxidizing influences. It would seem likely, therefore, in view of the perfect preservation of the water mains under conditions that lead to the destruction of wrought iron and lead pipes, whether through design or not, the large pipes have been made of a quality of iron that insures their safety.

(5.) Excavations were made in not less than fifteen places upon the water mains where tests upon the hydrants showed what was regarded as decisive liability to damage. The mains at these excavations were in nearly every instance inspected, and in no instance did we find evidences of corrosion distinctly attributable to electrolytic action. Perhaps the most notable instance examined was at the foot of First street, between Bond street and the canal. The fall in potential from the hydrant at the end of a branch was on the average 4 volts into the water of the canal at a distance of about 40 feet. There was a considerable fall of potential from point to point in the earth between the hydrant and the canal. Upon having the pipe uncovered I found that the fall in potential from the pipe to a point in the earth less than an inch removed from the pipe was .36 of a volt. The cast iron pipe showed no evidence of electrolysis, but what is to be specially noted in this case is that certain wrought iron clamps and bolts employed to fasten a cap upon the end of the pipe were seriously injured by corrosion. Lead service pipes, wrought iron clamps and belts, immediately attached to the uninjured cast iron and exposed to the same condition, showed unmistakably the expected electrolytic corrosion.

From a careful investigation of the facts, so far as we are able to proceed with it, I think it is at least safe to suggest that at low potentials cast iron of such quality as exists in the water mains which were examined will endure practically unharmed a flow of current into the earth which, under the same conditions, is totally destructive to wrought iron and lead.

The whole proposition with respect to the electrolysis of cast iron pipes must be left by us with the summary statement that although we hunted for it to the extent of the time and means provided, and in situations where, under the generally accepted principles of the subject, we expected to find it, we did not find a single instance of corrosion of cast iron which we could attribute to the action of electricity. But, granting that the city's water mains are not so seriously menaced by the trolley currents as has been supposed, all this does not help the situation with respect to wrought iron and lead service pipes, or with respect to wrought iron gas pipes or electric conduits or lead cable sheaths, all of which were found to be attacked and rapidly destroyed under conditions by which the cast iron mains appeared to be unaffected.

Methods of Preventing Electrolysis by Return Wires.—(1.) Bonding of rails or providing a metallic return conductor equal in sectional area and conductivity to the outgoing wires is insufficient to wholly prevent damage to the pipes.

In Boston, in addition to the bonding of the rails, very large return wires are put in between the rails, in some cases being ¾ of an inch in diameter, and also return wires on the poles, amounting altogether to about 70 per cent. of the outward conductors; but this does not wholly retain the current upon the system of conductors. The following remedy has been tried in a New England city, and has given good results:

Extend from the negative or rail side of the dynamo an insulated return wire, either on poles or underground, throughout the entire length of the railway, including all branches. This return wire to be

of such size as to properly carry the current and to maintain the return path at a comparatively low resistance. For a track extending three miles in any one direction from the power house a No. 0000 copper wire would give a resistance of but 1 ohm from the most distant point. From this return wire frequent connections should be made to the track, about every 200 feet; these connections between the return wire and the rail should be of such size or shape as to cause the same resistance from the rail at all connections. Allow no ground connections on the dynamo and no direct connections to the rails without the proper resistance; the rails are also to be thoroughly bonded.

(2.) In Boston, for instance, where several years ago the situation was causing considerable alarm, the West End Street Railway Company, by making its return circuit of lower resistance, and by judiciously running leads to certain points determined by investigation, has greatly reduced the return corrosion, and has at least made the destruction of the pipes a matter of years rather than of months. In other places similar methods have been employed and they have been followed by a marked improvement.

(3.) In the places where action is found, special precautions in provision of return feeders and connections with the piping system with the street railway company will ordinarily reduce the difficulty to a small amount. The most practical way of reducing the liability to injury to pipes to a minimum is by detecting the places where action is occurring through a carefully organized system of inspection and tests, and requiring the railway company to provide suitable return conductors or make proper connections with pipes or rails where it is found that such action exists.

(5.) If a suitable and complete system of return feeders were worked out and applied to the entire surface track of the city it would be reasonable to expect the reduction of a large proportion of the damage now being committed upon the pipes, and it would leave fair hopes of treating by other means the residue of the trouble so as to bring it within bounds.

(6.) In addition to the bonding a continuous supplemental wire shall be laid in the center of each track and connected to each rail at least every 300 feet extending the whole length of the road from the power house and connected to the negative side of the generator. The size of the wire shall be equal in area to that of all the feed wires that supply power over the section, allowance being made for the bond wires. No wire less than a No. 0 shall be used. In all cases the wires are to be connected to the negative side of the generator.

(7.) If a number of railway lines are operated from one power house, and particularly if the power house is not on the line of the railway, ample return feeders should radiate out to the various centers, so as to relieve the overloaded rails, and these return feeders should be well insulated to preserve them and also to prevent leakage to the ground. However, even with such careful and ample provision for the return current through the rails and insulated return feed wires or cables, a certain percentage of the current is, especially in moist earths, bound to leak through to some other conductor, and the amount thereof will depend upon the combined resistance of the earth and conductor compared to that of the rail or other return circuit. With a proper bonded rail circuit, reinforced by insulated return wires or cables from central points, such increase of current on any water pipe is not easily possible, as the resistance offered by the water pipe is very low, the metallic section of a 6-inch water pipe being 1½ times that of a 70 pound rail, while that of an 8-inch pipe is 2½, and of a 12-inch pipe 3¾ times as great. Therefore, the perfecting of the circuit from the pipe to the generator, in such cases, is generally sufficient provision to protect the water pipes from the electrolytic action.

Bonding Rails.—(1.) The importance of good bonding is great, but no amount of bonding will wholly prevent a portion of the current from following the pipes.

(F. O. Rusling). From my experience with copper bonds I should not advise the use of buried rails for conduits if ordinary copper bonds are used for connections. Even when new it is impossible to get the full conductivity of the rail, and the contacts get worse and worse as time passes. The copper when covered with the damp earth will oxidize at a rate determined by the composition of the soil and the amount of current transmitted.

(6.) The rail on any street railway shall be a continuous rail electrically welded at the joints, or if separated or distinct rails are used they shall be bonded or connected at the rail joints as shown by the following requirements:

For all rails weighing 40 to 60 pounds per yard, there shall be one bond of No. 0000 B.W.G. copper wire at each joint; for all rails weighing from 60 to 90 pounds per yard, there shall be two bonds of No. 0000 B.W.G. copper wire. Where the copper wire is joined to the rails the holes through the rails shall be carefully drilled and the No. 0000 copper wire made to carefully fit the hole. A thread shall be cut in the end of the wire, and a copper nut or a copper washer with iron nut shall be used and the surface of the rail so smooth and dressed that when the nut is made tight there shall be a thorough contact with the rail. The contact of the wires with the rail to be made on bright surfaces and the end of the copper wire to be enlarged so as to have not less than ten times the area of the bonding wire in contact with the bright surfaces of the side and hole of the rail, and with a close fit in the hole of the rail so as to make a waterproof joint. Immediately after the bonds are put in as above specified, the whole shall be thoroughly painted with the best electrical insulating paint. At every other rail the track shall be cross bonded with a No. 0 wire. Connection is to be made to the loop of the nearest bond with a wrapped joint and solder. On double track construction both tracks shall be connected together in the manner above specified.

(7.) The rails which in the first instance receive the return current unquestionably possess, if of ample section and without joint, sufficient conductivity to return all the current to the generator, excepting what in any case under the law of divided circuits is certain to escape to other conductors if such exist; therefore, all that is necessary to obtain the most perfect insulated and available conductor is to reduce all possible resistance at the rail ends by providing a most perfect bond between them equal to the rail in conductivity, or in other words by riveting a copper bond of about 12 inches in length to the rail ends, the section and number of these bonds to increase as the power house is being approached, supplemented by similar cross bonds connecting the four rails to each other every 100 to 120 feet.

Connections with Pipes.—(1.) Frequent connections with the water pipes should be avoided; such connections will reduce the action near the power station, but will increase it in other portions of the city.

A large conductor extending from the grounded side of the dynamo entirely through the danger territory and connected at every few hundred feet to such pipes as are in danger will usually insure their protection. It is better to use a separate conductor for each set of pipes to be protected; connections only at the power station to water or gas pipes will not insure their safety. Connections between the pipes and rail or rail return wires outside of the danger district should be carefully avoided.

(2.) Tests made by us show that if a large current is flowing longitudinally in an iron pipe even with good joints an injurious action is likely to occur at the joints. * * * From this test it is evident that the flow of an electric current along an iron pipe will increase the rate of decay of the pipe to some extent.

(5.) In this connection it has been objected that any plan which permitted the attachment of conductors from the pipes to the return systems of the railroads would, by promoting the increased flow of current along the pipes, cause a very serious corrosion at the joints in the pipes through an indefinite extent of the city. In one case where the water pipe was examined the drop in potential around joints in the main was found to be from one to two volts and there were no evidences of electrolysis or any other corrosion to be found.

(6.) Under no condition shall the current be grounded by means of wires or rods at any point near the gas or water mains or the iron or lead pipe connections.

(7.) If after return conductors have been provided the pipe is still positive the rail bonds at such points should be perfected, and if the connections are such that an increase of the section or number of such bonds will not entirely remove the difficulty, proper and suitable metallic connections should be made at such places between the pipe and rail so as to permit the return of the current to the rail; but they should only be made where the pipe is positive, in order to relieve the pipe and for no other purposes.

Whether there is sufficient resistance in the lead joints to cause some of the current to pass around and in doing so produce electrolytic action, in a measurement made on August 9, 1894, at the lead joint of an 8 inch water main in front of the power house of the Milwaukee Street Railway Company through which main 16 per cent. of the entire output of the station is being returned, a drop of potential of but .0196 volt was found to exist between the ends of the pipe, indicating a resistance of .000047 ohm, certainly not sufficient to produce electrolysis even with the most favorable conditions existing at the joints. A most careful examination of the pipes and the lead joints in the 8-inch main referred to did not show the least perceptible action or corrosion, although the main had been used as a conductor for years. It does not seem, therefore, that there is the least cause for any anxiety that

corrosive electrolytic action will take place at the lead joint and hence a water main of like diameter may safely be considered to possess a uniform conductivity throughout and capable of conducting without injury so much of the current as under the law of divided circuits it cannot avoid conveying.

Remarks.—(1.) It is advisable to connect the positive pole of the dynamo to the trolley lines. Frequent voltage measurements between pipe and earth should be obtained and such changes in return conductors made as the measurements indicate.

(2.) If the current be kept from flowing in the buried metal or if it can be prevented from flowing into the earth from that metal the corrosion can be stopped. To get rid of electrolytic action it is consequently necessary either to make the regular return circuit of such low resistance that there will be no flow in the pipes, which is practically impossible, or so to arrange return feeders that the current will not leave the pipes for the earth.

(3.) It is impracticable to eliminate electrolytic action, but by a constant inspection of the water system as a whole, with a view to locating points where difficulty is liable to occur, and applying such remedies as are well known, the danger can be reduced to a minimum.

(4. 1896.) The trolley companies have, during the year, done much to keep the destructive current in the path of their own conductors, so that the injury is doubtless less rapid than it was two years ago, but a means of absolute prevention of injury, so long as the pipes are of a kind liable to corrode, is not yet made known. The escape to the earth of a portion of the current discharged into the rail is a condition inseparable from the single trolley system.

(5.) But after every advisable effort has been made in this radical method of reducing the overflow of current, namely, by improvements in the bonds and return feeders, there will yet inevitably remain considerable, though diminished, earth currents, which will subject the pipes to electrolysis under favorable conditions.

SPECIAL ENGLISH CORRESPONDENCE.

COMMUNICATED BY NORTON H. HUMPHRYS.

SALISBURY, ENGLAND, Oct. 9th, 1897.

Incandescent Gas Lighting.—The Bicycle.—A Protest Against High Salaries.—Autumn Trip of the Institution of Gas Engineers.

Two new makes of incandescent gas burners are being introduced this season. The Denayrouze burner, which was exhibited at the recent meeting of the Gas Institute, is being tried for street lighting and other purposes, and the Bandsept burner, which was referred to by Prof. Lewes at the same meeting, is more suitable for ordinary house or shop lighting. In both cases the inventor seems to have aimed at producing a burner suited for use with the mantles already on the market, and to have worked upon the facts that by increasing the proportion of air admitted to or mixed with the gas previous to combustion, and by improving the intimacy of the mixture at the same time, a more regular and higher temperature of flame is secured, increasing the duty per cubic foot of gas used and prolonging the life of the mantle. It will be remembered that M. Denayrouze sought to gain this result in the first place by mechanical means, such as a small fan worked by electricity. But the results of further research have enabled him to dispense with costly or complicated machinery. He has simply modified the shape of the burner between the air inlets and the outlet to the flame, but requires a somewhat higher pressure, and therefore recommends using the burner without a governor or regulator. This is rather an objection where the pressure is liable to fluctuation. The mantle supplied with this burner is made by the Welsbach Company, but larger than their ordinary pattern, and an illuminating power of some 150 candles is claimed to be obtained with less than 10 cubic feet of gas per hour.

A chimney is not necessary, and this adds to the practical effect, as even a clear glass chimney or bulb obstructs some 10 per cent. of the light. I have been using two of these burners in ordinary hexagon street lanterns for some weeks, the only alteration made being to close in the bottom and otherwise check the admission and outlet of air, and the result is so satisfactory that six more are to be used. The Bandsept burner can be used at ordinary pressures, with a governor, and is provided with means for adjusting the supply of air to suit the quality of the gas. With the ordinary Welsbach mantle a duty of nearly 30 candles has been obtained per cubic foot of gas—a remarkable result, not only on account of the large advance on other methods, but also as to the prospect opened up for the future. Not only is there the accomplished fact of making 1 cubic foot of gas give as much value as 10 cubic feet consumed in the ordinary flat flames, but there is no reason to believe that the maximum has been touched, and so large an advance in a comparatively few years holds out good prospects for the future. It is not so very long since a duty of 10 candles per cubic foot was quoted as a remarkable accomplishment, and already this has been trebled, and the managers of gas undertakings would do well to encourage such advance by every means in their power. Why not offer a substantial honorarium to the party who is the first to produce a duty of 40 candles per cubic foot under certain specified conditions?

I have also seen the Bandsept burner used with the "Sunlight" mantles, the result being a warm, ruddy light of a comforting and cheering kind, which, being rich in red and yellow rays, would have a greater diffusive and penetrative power with regard to fog than a cold white or blue light. The light of the future, in cold climates at any rate, will have to retain the warmth and cheeriness of a good flat flame gas burner, which is especially evident on a damp, foggy night.

Two shillings and sixpence per 1,000 cubic feet, or threepence per 100 cubic feet, is a fair average for larger towns in England. Figuring on this price, M. Bandsept has shown us how to get a lighting effect equivalent to 1,000 candle hours at a cost of a penny. Truly, gas is well described as "the poor man's friend." A brilliant, cheerful light is a great desideratum even in the humblest home, and we must also remember that the increase of duty not only reduces the cost, but also vitiation of air and production of carbonic acid, as well as other defects which have been so strongly labored by those interested in introducing non-combustion methods of lighting. The methods adopted by M. Denayrouze and M. Bandsept tend to totally prevent evolution of carbonic oxide or other products of incomplete combustion.

The bicycle seems likely to become a useful implement to gas companies. Amongst my own staff there is an individual who now habitually brings his machine to the works and finds it very handy for taking messages or making visits to various parts of the district. Repeatedly he has made a call three miles away and returned within 30 or 40 minutes. At the recent meeting of the Pacific Coast Association I notice, amongst other ingenious devices, a wrinkle that implies that the use of this time-saving device is not uncommon in California, and in the last issue of the *Journal of Gas Lighting* there appears an advertisement for an outdoor inspector which sets forth that a "cyclist will be preferred." The lovers of the wheel can therefore boast that they have taken up something more than a mere pastime or even a healthy physical exercise. One special advantage is that the bicycle is an excellent measurer. The circumference of the driving wheel is usually accurately known, so, with the aid of a counting machine, or even without, a district of several miles can be accurately surveyed in a day. It may even be relied on to give the number of 9-foot or 12-foot pipes actually laid. For supervising outdoor operations of any kind that are being conducted at a distance from the office, it is so useful that any gas manager may learn to ride with advantage to himself and his undertaking.

Some of the Edinburgh and Leith Gas Commissioners have followed a singular method of showing their disagreement with recent advances of salary that have been granted amongst the superior officers connected with the gas undertaking. Recently a proposition was brought forward for making a trifling rise—about 1½d. per day—in the wages of the laborers employed by the Commissioners. Naturally there has been some casting about as to the reason of such an extraordinary proceeding. The men were well paid and were satisfied, and had not moved in the matter at all. And the only explanation forthcoming is that the proposition was intended as a protest against the raising of the salaries of some of the higher officials. The public of Edinburgh will not begrudge the small extra expenditure, particularly as it all goes into the pockets of their humbler fellow-townsmen. But there is a sort of ungraciousness about the action that will not increase its value to the parties immediately interested, and certainly will not encourage the "higher officials" referred to. The gas undertaking is in a flourishing condition, the demand is increasing rapidly and the price has been reduced, and under such satisfactory circumstances some revision of salaries amongst those whose labor and ability have assisted in securing such a result is only a fair and reasonable thing. And the Commissioners will find that it is very unwise, in the best interests of the concern, to exhibit niggardliness in the matter of salaries, and also that they are playing with edged tools in discussing such questions as the daily rate of wage to be paid. This is essentially a point that should be left to the discretion of the foreman or superintendent immediately controlling the men. The episode is worthy of consideration in connection with the question of the desirability of "municipal control" of gas undertakings. The "control" at times shows a tendency to extend into the

manager's office and interfere with questions that should properly be left to the staff on the works. I could quote many instances of the "control" being exercised in an erratic and ill-devised manner, and of the intrusion of motives into the business that would not be tolerated in a joint stock company's board room. The director of a company has simply to care for the interests of the shareholders. But the member of a town council has to give more attention to the wishes of his party or constituents than to the actual merits or defects of the matter in hand. In another Scottish Corporation, who are also owners of the local gas works, the question of advertising an old boiler for sale was discussed, one member being apparently troubled with qualms of conscience as to the act of selling a thing that was no use to them to somebody else. Apparently he jumped to the conclusion that there was some deception and that the purchaser would be supplied with a useless article. At the same meeting there was a long and heated discussion over a few hours' delay in attending to an escape of gas in one of the streets. There are other escapes of gas in that town besides those from the gas mains.

The members of the Institution of Gas Engineers have gone on the Continent for their usual autumn outing this year. The party left London on the 14th ult., under the personal guidance of the President, Mr. Corbet Woodall, and proceeded to Amsterdam, then to the Hague, next to Brussels, and finally to Antwerp, returning home on the 21st. Amsterdam was the main object of the visit, where they were hospitably received by the Imperial Continental Gas Association and afforded an opportunity of inspecting the gas works. At the Hague they received similar courtesies from the municipal gas department of the Corporation, and were also entertained at luncheon by the Dutch Association of Gas Managers. At Brussels a kindly welcome was accorded by M. Aerts, the Director of the municipal gas works, which is generally known as a thoroughly advanced and go ahead concern. The President, who is as well known in many parts of the Continent as he is in England, appears to be largely responsible for this pleasant innovation on the ordinary routine, which proved to be satisfactory in every way. There is a considerable amount of sameness about all English gas works, but in other countries other ways of doing things, other financial conditions, etc., come into play, and therefore a visit of this sort cannot but prove more valuable and suggestive than any amount of stay-at-home excursions. It is not granted to every gas manager to be able to travel in foreign lands, but to acquire anything like a broad view of the gas industry one must study its conditions in more than one country. It would be well if there was a more general disposition on the part of Boards of Directors and Commissioners to recognize the advantage of not only the ordinary meeting for the discussion of papers and communications, but also of so called pleasure excursions such as the trip to Holland that accrues to their own business. The general idea is to look upon the manager as a sort of automaton that should be chained to his desk all the year round. The manager, they say, should be always at the works. The Association meeting is looked upon as a kind of bean feast affair, at which a small show of business is made to serve for the covering of a holiday jaunt, and if the manager is granted his expenses to the meeting it is done in a sort of indulgent spirit. He has obtained good results for the undertaking, and therefore is not begrudged a little pleasure. But this is not the point. What the director or gas commissioner should appreciate is that although steady application to duty is bound to exercise a useful effect, the man who grinds on in the same old track, week after week and month after month, cannot be expected to keep in touch with every new improvement. The monotonous routine of daily duty has a deadening and not a stimulating effect. It is to their interest to encourage their manager, not only to steady, diligent service, but to a continual watchfulness for every means of improvement. And there is no better way of cultivating this than by paying his expenses to the Association meeting, where he will not only have an opportunity of inspecting modern extensions in gas engineering, but will hear of every new idea that has been tried, and will be encouraged by the successes and warned by the failures. Even one single wrinkle that he takes home may mean thousands of pounds to his employers. And he will come back not only refreshed in body, but with his wits sharpened up, ready and eager to apply the information he has gathered to his own particular district. When these points are properly appreciated in the board room, we shall hear no more about the gas engineer who does not attend the Association meeting because he is not inclined to bear the whole of the expenses out of his private purse.

SUPERINTENDENT HOLLIDGE, of the Merced (Cal.) Gas and Electric Light Company, has about completed the plant improvements arranged for that system early last summer.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

FORMER United States Senator, John R. McPherson, who died in Jersey City, N. J., on the night of the 9th inst., was one of those most prominent in the organization of the Peoples' Gas Light Company, of Jersey City, N. J. In fact, if we mistake not, he was the first President of that concern, the securing of the charter and franchise for which was marked by many queer happenings.

THE Clyde (Ohio) Gas Company, which was recently organized for the purpose of supplying illuminating gas in Clyde, has purchased the natural gas system of mains formerly operated by the Northwestern Natural Gas Company, and has also contracted with the United Gas Improvement Company for a water gas plant rated to a capacity of 100,000 cubic feet per day.

WE understand that Mr. Lewis Brittain, Superintendent of the Washburn and Moen Manufacturing Company, has purchased the rights and property of the concern that some time ago undertook to manufacture and supply gas in Waukegan, Ills. The further understanding is that such transfer means the speedy construction of a gas works in Waukegan. There is no doubt that such an undertaking would return a fair profit.

THE upper and lower branches of the City Council, of Wheeling, West Va., in joint session, something less than a fortnight ago, selected the following named gentlemen as members of the Board of Gas Trustees: E. Buckman, H. F. Ford and Julius Pollock.

THE Camden (N. J.) Gas Light Company has placed quite a number of prepayment meters, all of which are yielding satisfactory returns.

THE proprietors of the proposed opposition Company for Trenton, N. J., mention of the incorporation of which was made in the JOURNAL for the 11th inst., have made formal application to the Common Council for a governing ordinance. The agreement, which was prepared by Mr. John H. Backes, counsel for the Company, provides that it is to have the right to use the streets; that it shall, within three months after the approval of the ordinance, file in the office of the City Clerk a certificate of acceptance of all of the provisions and conditions of the same, and shall pay for the cost of publishing the ordinance; that the Company shall, at the time of the acceptance of the ordinance, enter into an agreement with the city of Trenton to commence work within one year from the date of the approval of the ordinance; and, further, that the Company will furnish and supply gas to the city of Trenton, for the lighting of the streets and public buildings, at a price not to exceed $1 per 1,000 cubic feet; that the Company shall enter into a bond to the city of Trenton, in the penal sum of $25,000, conditioned that it will comply with the terms of the ordinance and its conditions, and that it will not unnecessarily disturb any street, lane, alley or square occupied or used by it; but will complete each part of the work commenced as speedily as possible, and repair and restore said streets, lanes, alleys or squares, to as good condition as existed before said work was commenced; that it will indemnify and save harmless the city from all damages that may arise from the laying of pipes in the streets of said city or the conveying of gas through the same. That the work on the streets shall be under the supervision of the city officials; and that the Company shall pay the expenses of the City Engineer in such service.

EVERYBODY in Trenton, New Brunswick, Elizabeth, Newark and Jersey City knows full well what this proposition by the gentlemen in control of the opposition movement in gas supply for Trenton means—that is, everyone at all conversant with the moves on New Jersey's gas chessboard.

THERE'S mourning in Indianapolis; for P. A. McDonald & Co., who proposed to supply gas in the chief Hoosier city at something "more or less" than 50 cents per 1,000 cubic feet, have disappeared. The only things the McDonald concern left behind them were debts.

WE are informed that Mr. A. C. Einstein, who has been interested for some time in the electric business of Paducah, Ky., has leased the trade and works of the Paducah Gas Light Company, the agreement to run for one year. The agreement also carries an option permitting Mr. Einstein and his associates to purchase the gas plant, within the twelvemonth, at a named figure.

How quiet Tammany is over that dollar gas slogan in the present campaign!

ADVICES by way of Baltimore, dated the 18th inst., are to the effect that the Isabella Gas Works, of Frederick City, Maryland, have been leased to Mr. F. B. Hope, of Philadelphia. The lessee proposes to add an incandescent electric lighting plant to the gas works possessions.

THIS is a part of the text of a notice recently issued by the proprietors of the City Gas Company, of Norfolk, Va.: "Owing to the recent action of the Welsbach Commercial Company, in bringing suits for infringements of its patents, we are compelled to refuse hereafter to sell Welsbach mantles for use in competing lamps. Gas consumers are hereby notified that these lamps are infringements, and that the Welsbach Company is now in other cities vigorously prosecuting buyers and sellers of the infringing lamps."

THE Alexander Smith & Sons' Carpet Company, of Yonkers, N.Y., have placed the contract for their fireproof dye houses with the Berlin Iron Bridge Company, of East Berlin, Conn. These buildings, which are to be 50 feet in width by 100 feet in length, are to be constructed of steel throughout.

THE Chicago newspapers report that the proprietors of the Peoples Gas Light and Coke Company—the successor to the Company known as the Chicago Gas Trust—will make no distinction hereafter in the metering of gas used on illuminating or fuel account. Nor do we understand why the Company should make such distinction, since the rate for a fuel or an illuminating gas supply is $1 per 1,000 cubic feet. The dual meter system, of course, was a necessity, when gas for fuel was sold at a figure lower than that charged for gas for illumination.

MR. WILLIAM MACKENZIE, who has for some time owned a controlling interest in the Manitoba Electric and Gas Light Company, of Winnipeg, Manitoba, is said to have secured by purchase the plant and franchises of the Vancouver Gas Company, of Vancouver, British Columbia. He proposes to enlarge the works and main systems of his new purchase.

THE contract for the public lighting of Louisville, Ky., in so far as that is performed by means of arc lamps, between the authorities and the Louisville Gas Company, has been signed by Mayor Todd. The price agreed on is $84 per lamp per annum, the hours of lighting being fixed at 3,900.

MR. W. H. SWINDELL, General Superintendent of Lamps, Baltimore, Md., according to the Baltimore *News*, recently cut short the operations of an itinerant meter inspector in that city. The Superintendent, in speaking for publication about the matter, said: "Our department charges $1 for an official test of a meter, which test is recognized by the Gas Company. This pseudo tester has been charging $5 for single tests, which tests are not only not recognized by the Gas Company, but which are absolutely inaccurate, as we proved through tests made by us of meters which he had tested."

THE argument in the Supreme Court of the United States over the Laclede gas case has been postponed to the first Monday in January.

THE report of the Joint Committee on Light and Finances to the City Council of Alexandria, Va., which Committee had been instructed to investigate the management of the municipal gas plant, is a severe arraignment of that management. In fact, the investigators found that, "instead of economy, waste has been the rule. It is recommended that the plant be placed under the control of one person, who shall be held responsible for its management."

THE Louisville (Ky.) *Post*, for the 16th inst., says that a meeting of the committee which has in charge the pooled stock of the Louisville Gas Company was held on the 15th inst., in the office of the Fidelity Trust Company. After the situation had been thoroughly discussed it was decided not to make any calls for bids on the stock at present. The committee has been approached by several persons who were desirous of submitting bids. It is more than probable that a final decision in the premises will not be reached before November 15th.

ON October 16th a certificate was filed in the office of the County Clerk, of Westchester, N. Y., by the Directors of the Westchester Gas and Electric Company, declaring that the capital stock of the Company is $300,000, of which one-half has been paid in. This is the concern that has succeeded to the rights and privileges formerly possessed by the Consolidated Gas and Electric Light Company, of Rye and Port Chester, N. Y.

IN the statement submitted by the officers of the Peoples Gas Light and Coke Company, of Chicago, with their application for the listing of the Company's securities on the New York Stock Exchange, the following presentation of the Company's bonded indebtedness was made—the bonds of the Chicago Economic Fuel Gas Company are in the treasury of the Peoples Company:

	Principal.	Annual Interest.
First mortgage bonds of the Peoples Gas Light and Coke Company, dated Nov. 9, 1874, and due Nov. 1, 1904, interest payable Nov. 1 and May 1	$2,100,000	$126,000
Second mortgage 6 per cent. bonds of the Peoples Gas Light and Coke Company, dated Dec. 5, 1874, and Due Dec. 1, 1904, interest payable Dec. 1 and June 1	2,500,000	150,000
First consolidated 6 per cent. bonds of the Peoples Gas Light and Coke Company, dated April 1, 1893, and due April 1, 1943, interest payable April 1 and Oct. 1	4,900,000	294,000
First mortgage 5 per cent. bonds of the Chicago Gas Light and Coke Company, dated July 1, 1887, and due July 1, 1937, interest payable July 1 and Jan. 1	10,000,000	500,000
First mortgage 6 per cent. bonds of the Equitable Gas Light and Fuel Company, dated July 1, 1885, and due July 1, 1905, interest payable July 1 and Jan. 1	2,000,000	120,000
First mortgage 7 per cent. bonds of the Illinois Light, Heat and Power Company, dated Nov. 18, 1885, and due Nov. 1, 1915, interest payable Nov. 1 and May 1	500,000	35,000
First mortgage 6 per cent. bonds of the Lake Gas Company, dated July 1, 1885, and due July 1, 1915, interest payable July 1 and Jan. 1	300,000	18,000
First mortgage 5 per cent. bonds of the Chicago Economic Fuel Gas Company, dated Jan. 2, 1893, and due Jan. 1, 1916, interest payable Jan. 1 and July 1	2,500,000	125,000
First mortgage 5 per cent. bonds of the Consumers Gas Company, dated Dec. 1, 1886, and due Dec. 1, 1936, interest payable June 1 and Dec. 1	4,246,000	212,300
Total	$29,046,000	$1,580,300

THE statement further shows that for the last 5 months of 1896 and the first 7 months of 1897, the quantity of gas sold measured 5,102,478,900 cubic feet; that the gross receipts for manufactured and natural gas in the same period amounted to $6,443,686.08; that the gross expenses (excluding interest on bonded debt) were, $3,486,416.05; and that the net receipts were $2,957,270.03. The mileage of mains returned is 1,306; meters in use, 158,842; public gas lamps, 30,705.

THE arrangements for the reorganization of the Macon (Ga.) Gas and Water Company are virtually completed. Under the arrangement the present officers will hold over until next April, when the regular annual meeting occurs. Meanwhile the Receiver will go on with the projected plant betterments, which latter will mainly apply to the water supply division of the enterprise. The sum to be expended on that account is estimated at $100,000.

THE Bristol (Tenn.) Gas, Electric Light and Power Company, has arranged to install an incandescent electric lighting plant up to the maintaining of 3,000 lamps of 16-candle power.

THE Kentucky Court of Appeals, in the instance of an appeal by the Owensboro Gas Light Company from a decision by the Daviess Circuit Court (the title of the case is, Owensboro Gas Light Company vs. J. J. Hildebrand), has decided in favor of the appellee. A resume of Judge Hazelrigg's opinion is: "A quasi public corporation practically having a monopoly in a city of furnishing light to the citizens cannot impose certain terms and conditions upon one consumer and other terms and conditions upon other consumers. They have a right to make reasonable conditions upon which they will furnish light, but such conditions must apply to all consumers alike, and may not be applied to any special consumer, according to the whim or caprice of the Company."

THE AMERICAN GAS LIGHT JOURNAL

A. M. CALLENDER & CO.,
PROPRIETORS.

THOS. J. CUNNINGHAM,
ELBERT P. CALLENDER,
EDITORS.

CHAS. E. SANDERSON,
MANAGER.

PUBLISHED ON EACH MONDAY OF THE YEAR AT
No. 32 Pine Street, New York.

The JOURNAL is the official organ of the
NEW ENGLAND ASSOCIATION OF GAS ENGINEERS.
AMERICAN GAS LIGHT ASSOCIATION.
WESTERN GAS ASSOCIATION.
OHIO GAS LIGHT ASSOCIATION.
PACIFIC COAST GAS ASSOCIATION.
TEXAS GAS AND ELECTRIC LIGHT ASSOCIATION.

TERMS:

SUBSCRIPTION—Three Dollars per annum, in advance. Single copies, 10 Cents.

AGENTS:

New York—American News Co., 39 and 41 Chambers St.
Germany—Lemcke & Buechner, of New York.
England—Aug. Siegle, 30 Lime Street, London.

MONDAY, OCTOBER 25, 1897.

The Electric Arc.

Mr. Carl Hering, in *Electrical World* for last week, "digests" an article from the London *Electrician*, on the subject of the electric arc. The digester chews the article by saying that the original writer deduced the practical efficiencies gained by certain modification, such as smaller carbons and longer arcs, basing his arguments on the results of tests which he made. He believes that a great range of possibilities lying latent in the arc have been left undiscovered and that the arc lamp of to-day is in almost the same elementary state and undeveloped originality as it was 90 years ago; there is a demand for small current arc lamps, using less than 5 amperes, and of these very few are used; the various ways of increasing the efficiencies of the arc are therefore of importance, because, unless the efficiency is better than that of large incandescent lamps, the latter would be used in preference. His discussion and experiments deal only with the direct-current lamp. After allowing a loss of 60 per cent. in the diffusion, the light from a nominal 2,000-candle power lamp is only about 500, and the useful light will therefore be obtained at an efficiency of about 1-candle power per watt, which is still far in advance of the incandescent lamp. He then determined the value of the light gained by reducing the diameter of the negative carbon by means of carefully verified photometric tests with lamps similar in all respects except the size of this carbon; while the results show the desirability of making this change, yet the increased efficiency is not of practical utility for all purposes; the curves for both are given, and while the gain is great the change is decidedly disadvantageous for public street lighting; the curves of illumination on a plane at right angles to the rays are given, and at 15 feet from the base the illuminations from a 12-millimeter and a 7.5 millimeter carbon, are 1.1 and 1.5 candle feet respectively; the latter, while considerably greater, is objectionable, as it makes a detrimental comparison with the darker parts, anything above 0.2 candle foot being too great a contrast, as it is glaring; when the lamps are to light up an area immediately around their base, the advantage of the smaller carbon is apparent.

He then discusses the effect of increasing the length of arc; a curve shows that the 55 volts which Carhart found gave a maximum efficiency, may be exceeded; a formula is given for the mean hemispherical candle power as a function of the voltage between 35 and 58; in using high voltages, the positive carbon is consumed to a more acute point; the increase of light after a certain voltage is past may be found in the varying forms of that part of the carbon undergoing volatilization; the present abnormal cross section of carbon is productive of the greatest of all its inefficiencies; the harder the carbon and the more homogeneous, the higher the heat necessary to vaporize it, and the efficiency is a function of this temperature; the crater should be kept as flat as is consistent with the maintenance of the arc, and this is one of the reasons why the air-tight type of lamp has a higher efficiency; another very important point is to diminish the heat lost by conduction; it is unanimously agreed by different experimenters that there is a decided gain in this direction produced by reducing the size of the carbons; the mean hemispherical candle power per watt may be increased 150 to 200 per cent. by using smaller carbons; this modification is, however, beyond our reach until some new form of arc has been placed on the market, which will allow longer and thinner carbons to be used; he makes an estimate showing that, compared with the enormous increase in illuminating power, the greater cost of trimming and of the thinner carbons are negligible; he urges central stations to adopt the improvements.

The Market for Gas Securities.

The trading in city gas shares during the week was rather more animated than usual, and a tendency towards higher prices was unmistakable. To-day (Friday) Consolidated opened at 210½, and at 2 P.M. the bid price was 212½. Standard common advanced sharply to 142 bid, an advance of 9 points for the week. The preferred for the same period shows a gain of 7 points. Original common and preferred in New York and East River are dull and lower, while Mutual is again 350 bid. Rumor is busy with what is to be done shortly in respect of visible manifestation over general consolidation; but nothing positive is to be chronicled this week. We repeat our well told exhortation that Consolidated is cheap at the market rates.

Brooklyn Union is steady, at 123 to 124, and the bonds are very firm, at 113 to 114, and interest. Chicago gas sold above 96 to day, and Laclede common is returned at 43½ to 44½. The Consumers Gas Company, of Jersey City, N. J., has declared a dividend of 2½ per cent., payable November 1. This puts the Company on a 5 per cent. per annum basis, instead of 4. The transfer books close to-morrow, to reopen November 1. Bay State gas is in marked disfavor. Quite some trading was done in it to-day, and the price for it at 2 P.M. was 5¾. Baltimore Consolidated is 59 to 60. Syracuse is quoted at 24 to 27. The Indiana group hold their position quite well, and people well informed as to the real standing of those properties predict much better figures in them shortly.

Gas Stocks.

Quotations by Cochran & Close, Brokers and Dealers in Gas Stocks.

35 WALL ST., NEW YORK CITY.

OCTOBER 25.

☞ All communications will receive particular attention.
☞ The following quotations are based on the par value of $100 per share.

N. Y. City Companies.	*Capital.*	*Par.*	*Bid.*	*Asked.*
Consolidated	$35,430,000	100	212	213
Central	500,000	50	..	..
" Scrip	220,000	..	100	.
Equitable	4,000,000	100	280	290
Bonds, 6's	1,000,000	1,000	105	.
" 1st Con. 5's	2,300,000	1,000	114	.
Metropolitan Bonds	658,000	..	108	112
Mutual	3,500,000	100	350	360
" Bonds	1,500,000	1,000	100	102
Municipal Bonds	750,000	.	..	.
Northern	150,000	50	..	
" Bonds	150,000	1,000	..	98
New York and East River	5,000,000	100	83	87
Preferred	2,000,000	100	103	110
Bonds 1st 5's	3,500,000	1,000	112	113
" 1st Con. 5's	1,500,000	..	105	106⅜
Richmond Co., S. I.	348,650	50	50	..
" Bonds	100,000	1,000	..	..
Standard	5,000,000	100	142	144
Preferred	5,000,000	100	147	155
Bonds, 1st Mortgage, 5's	1,500,000	1,000	114	115
Yonkers	299,650	50	130	..
Out-of-Town Companies.				
Brooklyn Union	15,000,000	100	123	124
" " Bonds (5's)	15 000,000	1,000	113	114
Bay State	35,000,000	50	6	6⅛
" Income Bonds	2,000,000	1,000	..	35
Boston United Gas Co.—				
1s Series S. F. Trust	7,000,000	1,000	93	..
2d " " "	3,000,000	1,000	80	81
Buffalo Mutual	750,000	100	125	..
" Bonds	200,000	1,000	95	100
Central, San Francisco	2,000,000	..	95	..
Chicago Gas Co.	25,000,000	100	96	96⅛
Chicago Gas Lt. & Coke Co. Guaranteed Gold Bonds.	7,650,000	1,000	104	104¼
Columbus	1,069,000	.	93¼	93½
1st Mortgage	1,085,000	..	..	96
Consumers, Jersey City	2,000,000	100	77	82
" Bonds	600,090	1,000	103	105
Cincinnati G. & C. Co.	8,500,000	100	201	202
Consumers, Toronto	1,600,000	50	184½	187
Capital, Sacramento	500,000	50	..	35
Bonds (6's)	150,000	1,000		
Consolidated, Baltimore	1,000,000	100	59	60
Mortgage, 6's	3,600,000	..	107	107½
Chesapeake, 1st 6's	1,000,000	..	..	..
Equitable, 1st 6's	910,000	..	..	..
Consolidated, 1st 5's	1,490,000	..	..	..
Detroit	4,000,000		48	50
" Con. Bonds	4,312,000	..	93	94
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1,000	..	101
Fort Wayne	2,000,000	..	81	85
" Bonds	2,000,000	..	93	95
Hartford	750,000	25	..	145
Indianapolis	2,000,000	..	118	125
" Bonds, 6's	2,650,000	..	107	109
Jersey City	750,000	20	180	..
Lafayette Gas Co., Ind.	1,000,000	100	86	88
Bonds	1,000,000	1,000	92	94
Louisville	2,570,000	50	..	..
Laclede, St. Louis	7,500,000	100	43⅜	44⅛
Preferred	2,500,000	100	95	97
Bonds	9,084,400	1,000	101½	102
Little Falls, N. Y.	50,000	100	..	100
Bonds	25,000	..	..	100
Montreal, Canada	2,000,000	100	200	.
Newark, N. J., Gas Co.	1,000,000	..	200	220
Bonds, 6's	4,000,000	..	128	130x

New Haven	1,000,000	25	225	..
Oakland, Cal.	2,000,000	..	53½	54
" Bonds	750,000	..	..	..
Peoples Gas Lt. & Coke Co., Chicago, 1st Mortgage	20,100,00	1,000	..	108
2d "	2,500,000	1,000	104	105
Peoples, Jersey City	500,000	50	..	175
Rochester Gas & Elec. Co.	2,150,000	50	..	..
Preferred	2,150,000	50	83	..
Consolidated 5's	2,000,000		87½	90
San Francisco, Cal.	10,000,000	100	94	94½
St. Paul Gas Light Co.	1,500,000	100	49	51
1st Mortgage, 6's	650,000	..	84	87
Extension, 6's	600,000	..	..	..
General Mortgage, 5's	2,400,000	..	88	90
Syracuse, N. Y.	2,500,000	25	24	27
Bonds	1,000 000		98	100
Washington, D. C.	2,000,000	20	250	
Western, Milwaukee	4,000,000	100	84	86
Bonds, 5's	3,556,000	..	98	100
Wilmington, Del.	550,000	50	200	202

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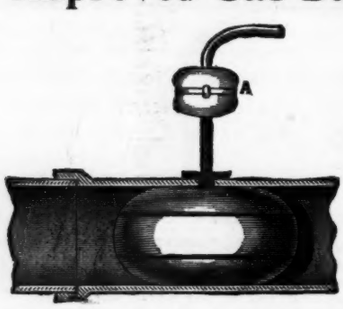

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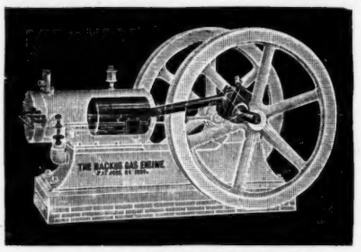

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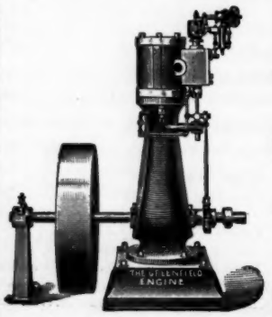

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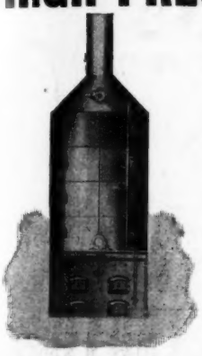

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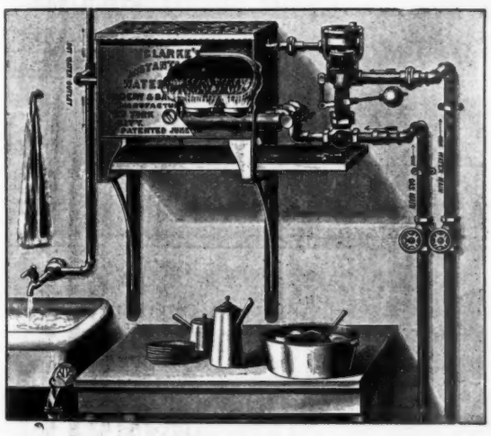

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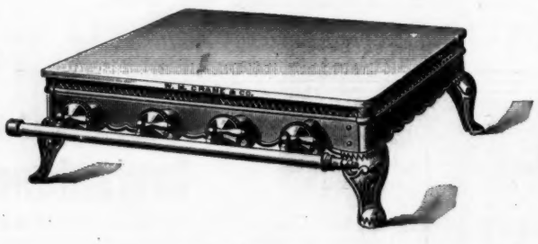

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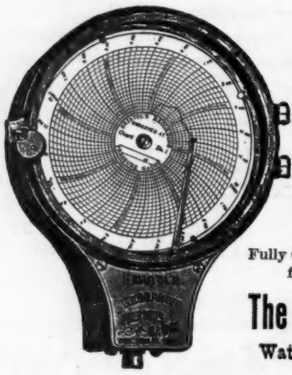

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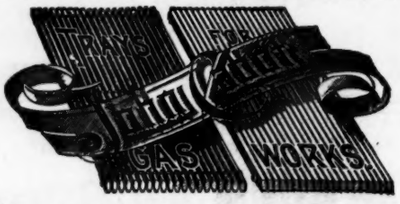

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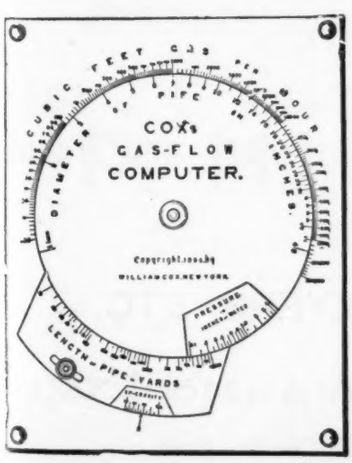

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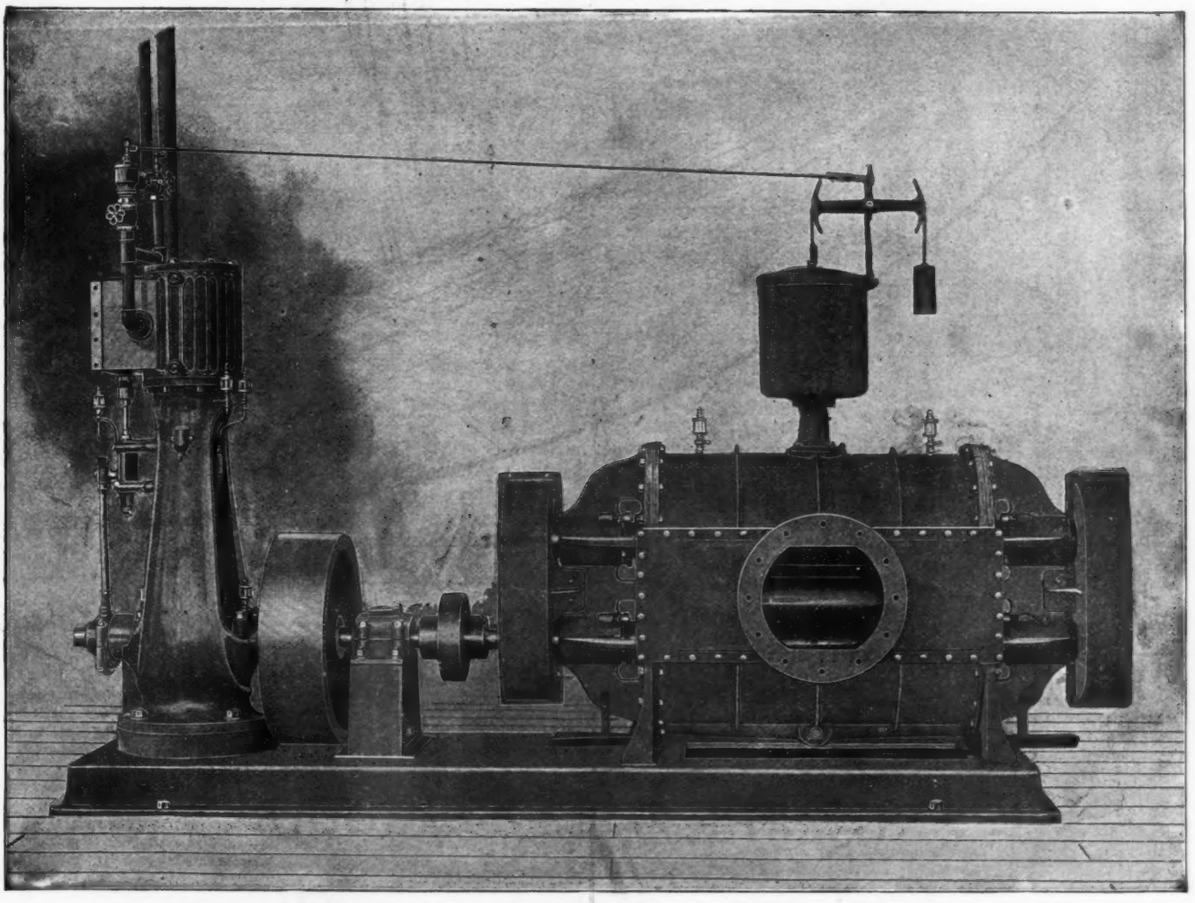

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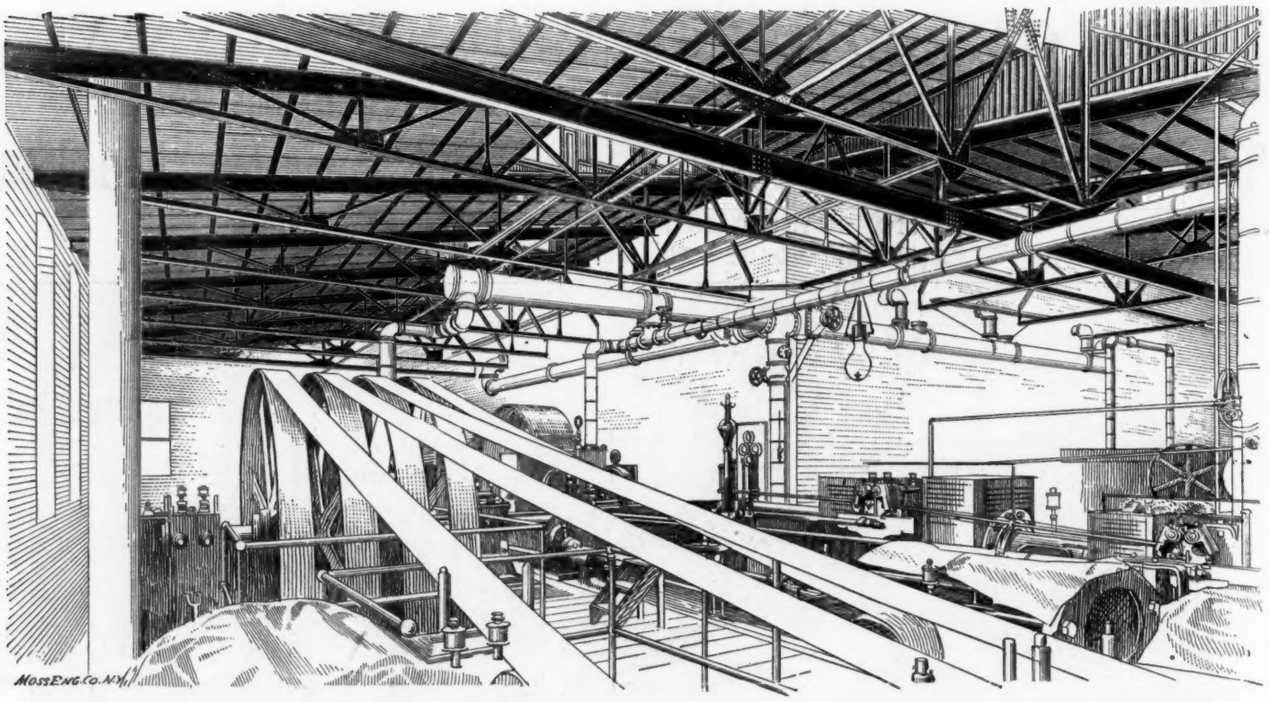

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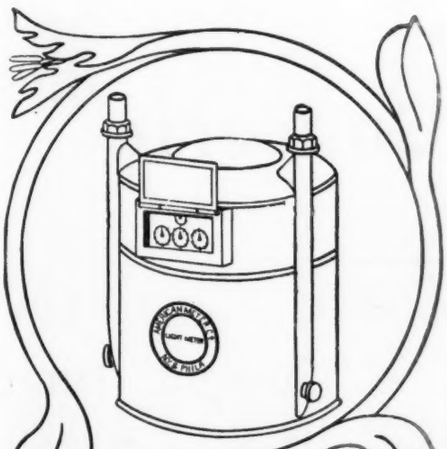

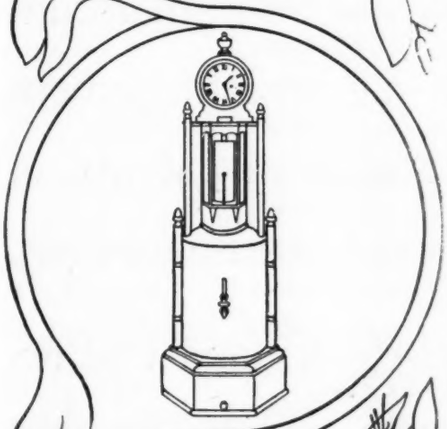

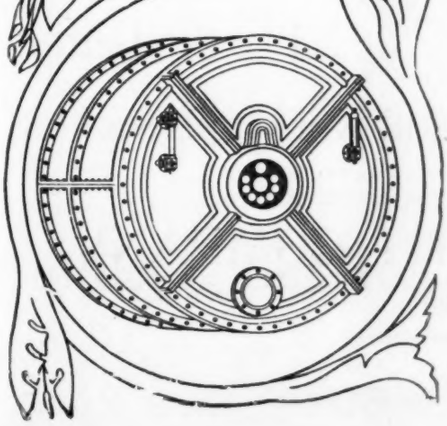

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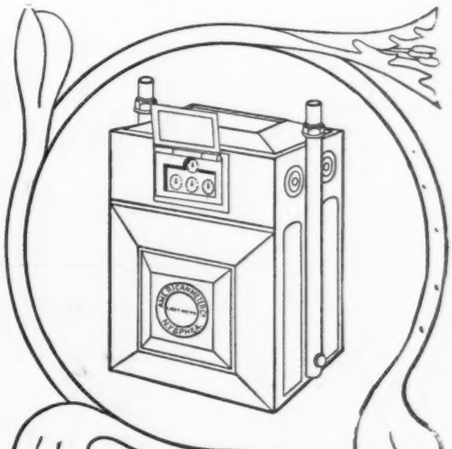
PUBLIC LIGHTING TABLE.

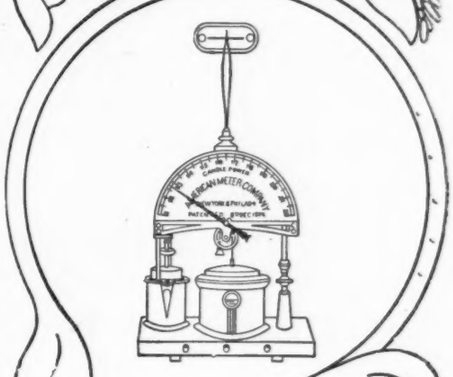
NOVEMBER, 1897.

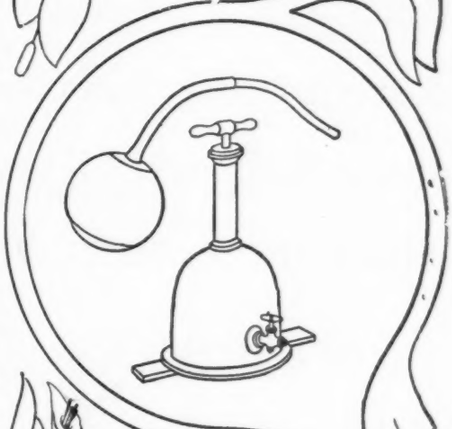
Day of Week.	Date.	Table No. 1. Following the Moon. Light.	Extinguish.	Table No. 2. New York City. All Night Lighting. Light.	Extinguish.
				P.M.	A.M
Mon.	1	10.40 PM FQ	5.30 AM	4.45	5.35
Tue.	2	11.50	5.30	4.45	5.35
Wed.	3	12.50 AM	5.30	4.45	5.35
Thu.	4	1.50	5.30	4.45	5.35
Fri.	5	3.00	5.30	4.40	5.45
Sat.	6	4.00	5.30	4.40	5.45
Sun.	7	No L.	No L.	4.40	5.45
Mon.	8	No L. FM	No L.	4.40	5.45
Tue.	9	No L.	No L.	4.40	5.45
Wed.	10	5.20 PM	6.20 PM	4.40	5.45
Thu.	11	5.20	7.00	4.40	5.45
Fri.	12	5.20	7.50	4.30	6.00
Sat.	13	5.20	8.50	4.30	6.00
Sun.	14	5.10	9.50	4.30	6.00
Mon.	15	5.10	10.50	4.30	6.00
Tue.	16	5.10	12.00 AM	4.30	6.00
Wed.	17	5.10 LQ	1.00	4.30	6.00
Thu.	18	5.10	2.10	4.30	6.00
Fri.	19	5.10	3.20	4.25	6.00
Sat.	20	5.10	5.50	4.25	6.00
Sun.	21	5.10	6.00	4.25	6.00
Mon.	22	5.10	6.00	4.25	6.00
Tue.	23	5.10 NM	6.00	4.25	6.00
Wed.	24	5.10	6.00	4.25	6.00
Thu.	25	5.10	6.00	4.25	6.00
Fri.	26	5.10	6.00	4.20	6.10
Sat.	27	5.10	6.00	4.20	6.10
Sun.	28	8.30	6.00	4.20	6.10
Mon.	29	9.40	6.00	4.20	6.10
Tue.	30	10.40 FQ	6.00	4.20	6.10

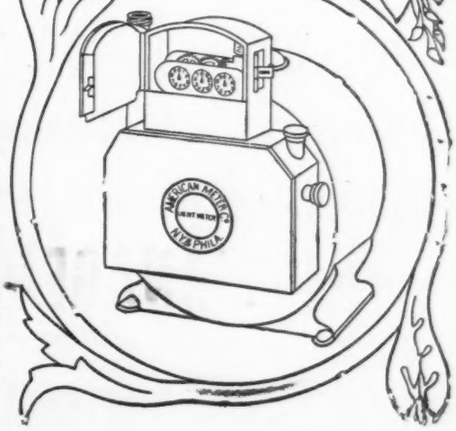
TOTAL HOURS LIGHTING DURING 1897.

By Table No. 1.	Hrs.Min.	By Table No. 2.	Hrs.Min.
January	233.00	January	423.20
February	187.20	February	355.25
March	202.00	March	355.35
April	170.40	April	298.50
May	163.00	May	264.50
June	140.40	June	234.25
July	151.40	July	243.45
August	167.30	August	280.25
September	174.40	September	321.15
October	200.00	October	374.30
November	205.20	November	401.40
December	220.10	December	433.45
Total, yr.	2216.00	Total, yr.	3987.45









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Year.	No. of Sets.	Daily Capacity.
1883	2	900,000 Cubic Feet.
1885	5	2,250,000 "
1886	8	2,650,000 "
1887	11	5,200,000 "
1888	5	2,450,000 "
1889	12	3,575,000 "
1890	21	10,050,000 "
1891	31	22,875,000 "
1892	25	15,575,000 "
1893	20	9,875,000 "
1894	22	10,525,000 "
1895	23	12,300,000 "
1896	30	19,550,000 "
1897	21	9,425,000 "

Total Number of Sets - 236

Total Daily Capacity - 127,200,000 Cu. Ft.

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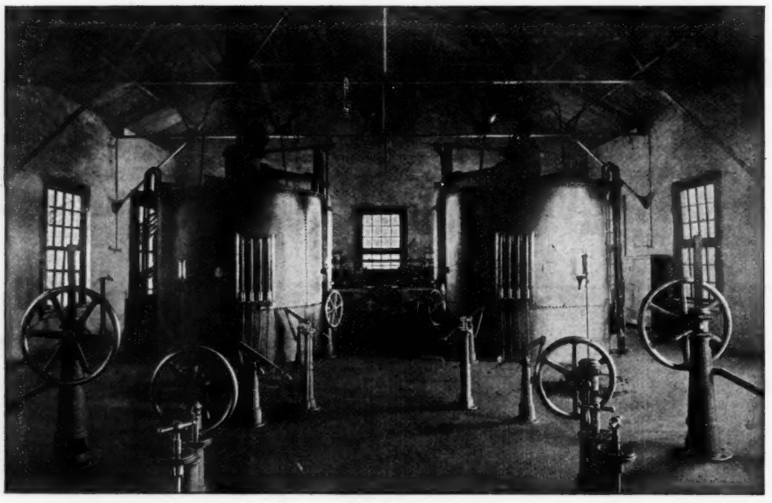

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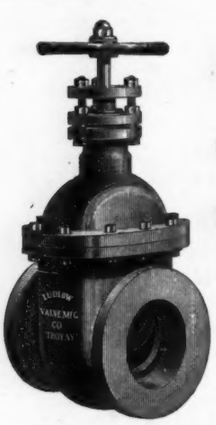

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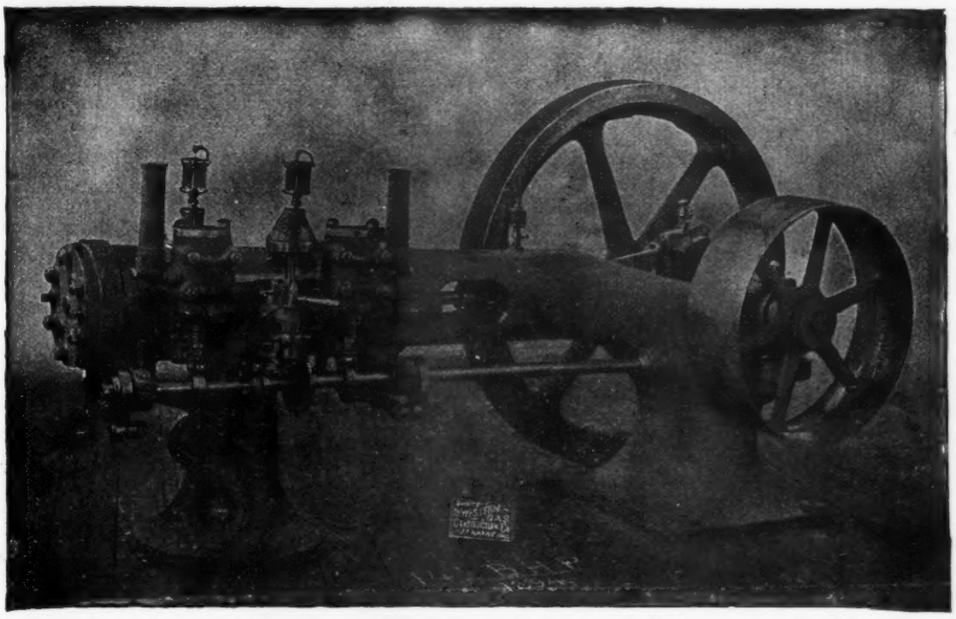

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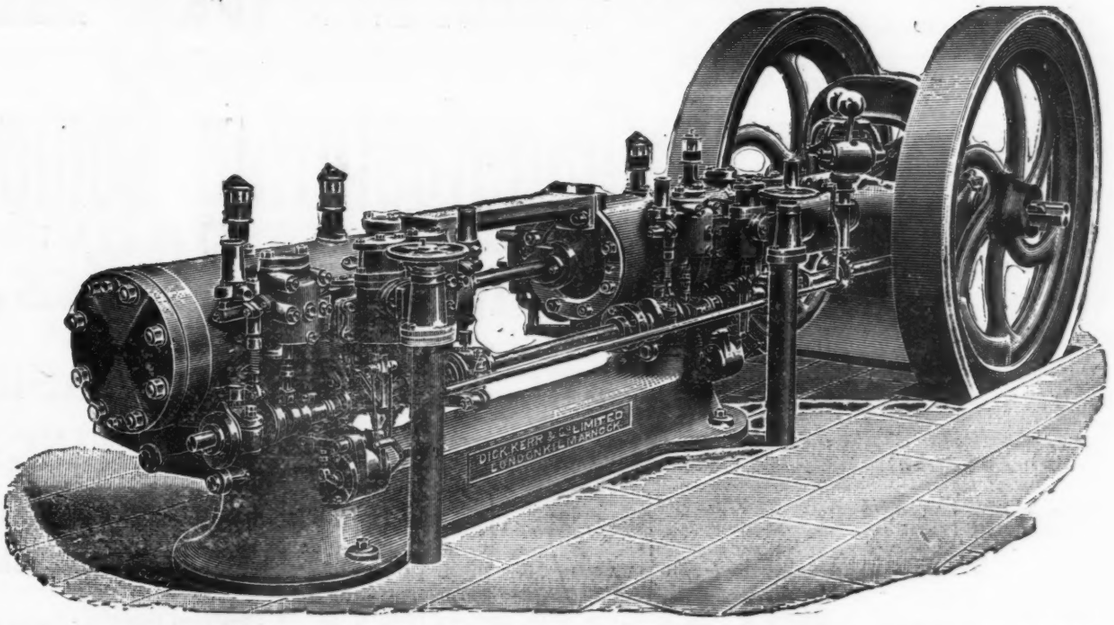

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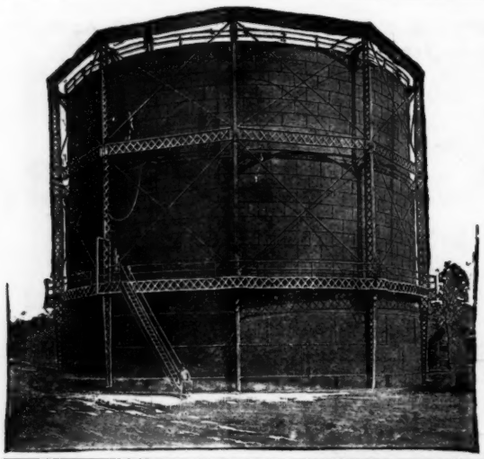

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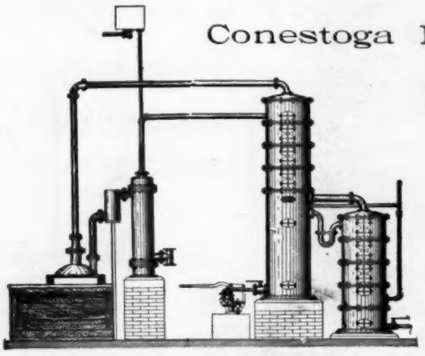

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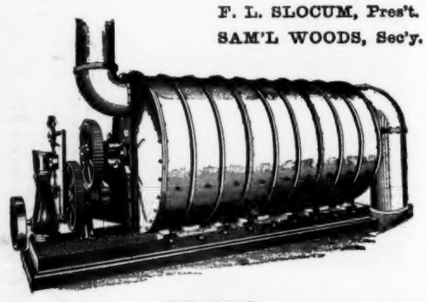

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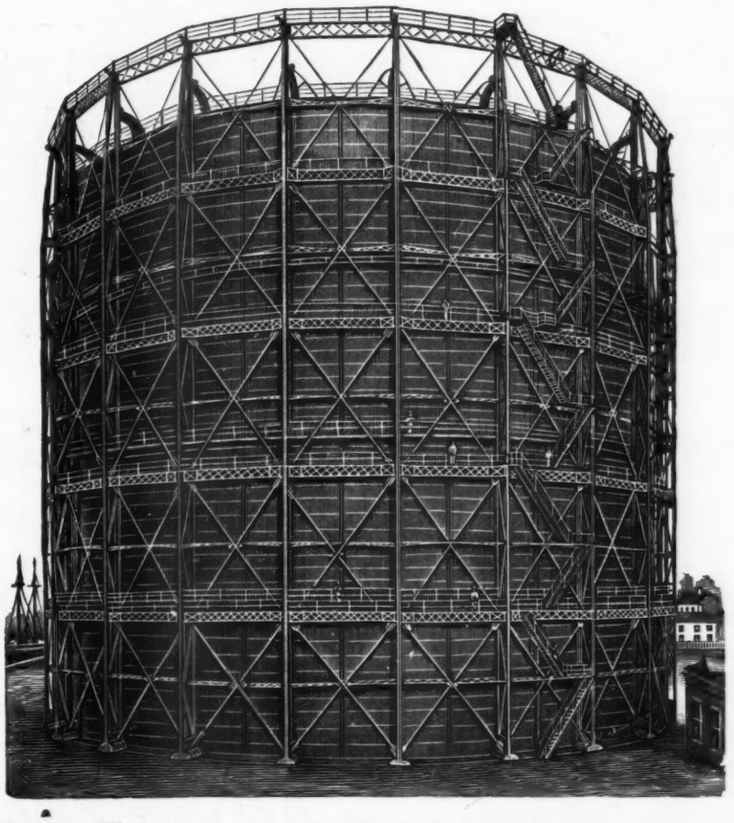

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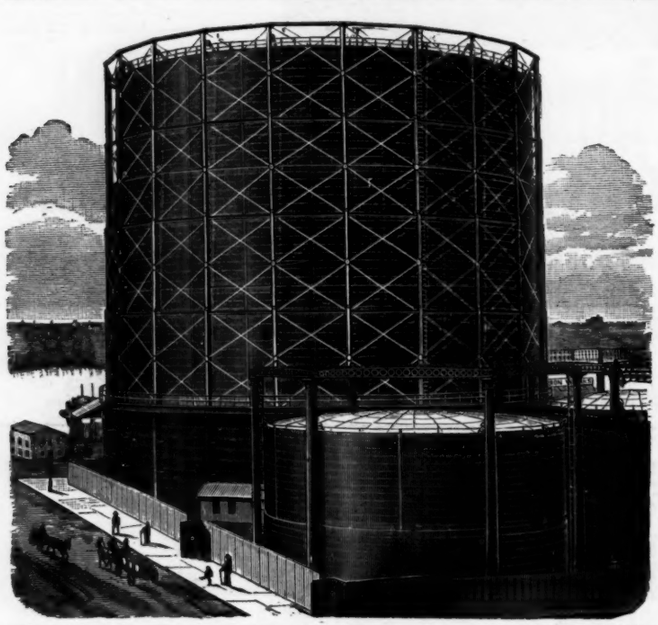

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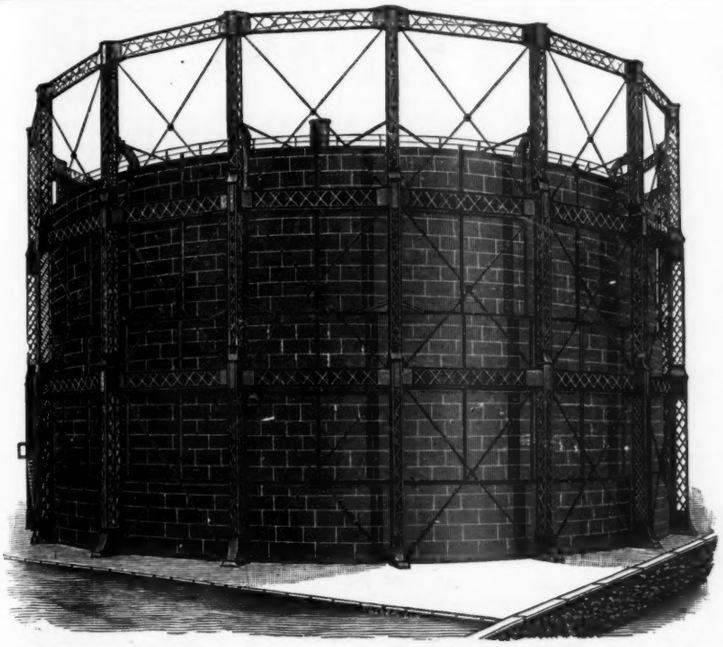

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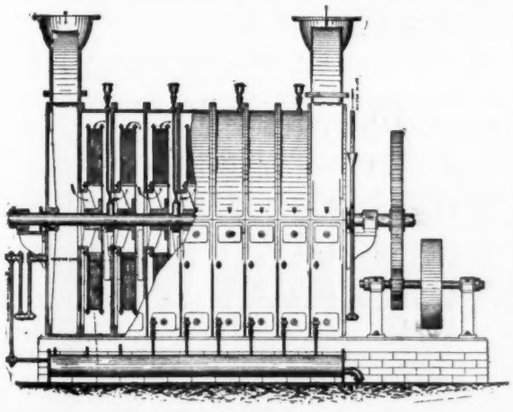

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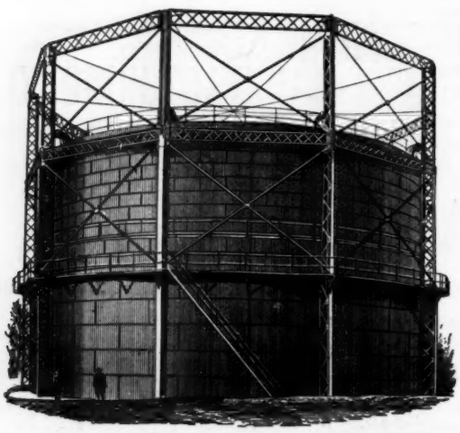

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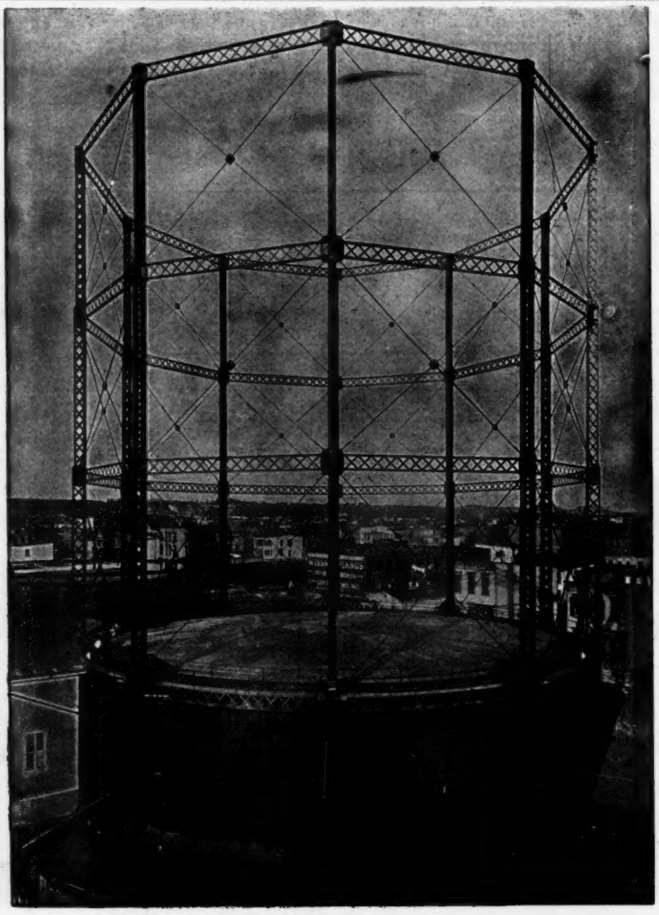

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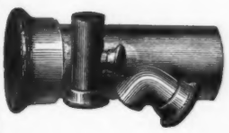
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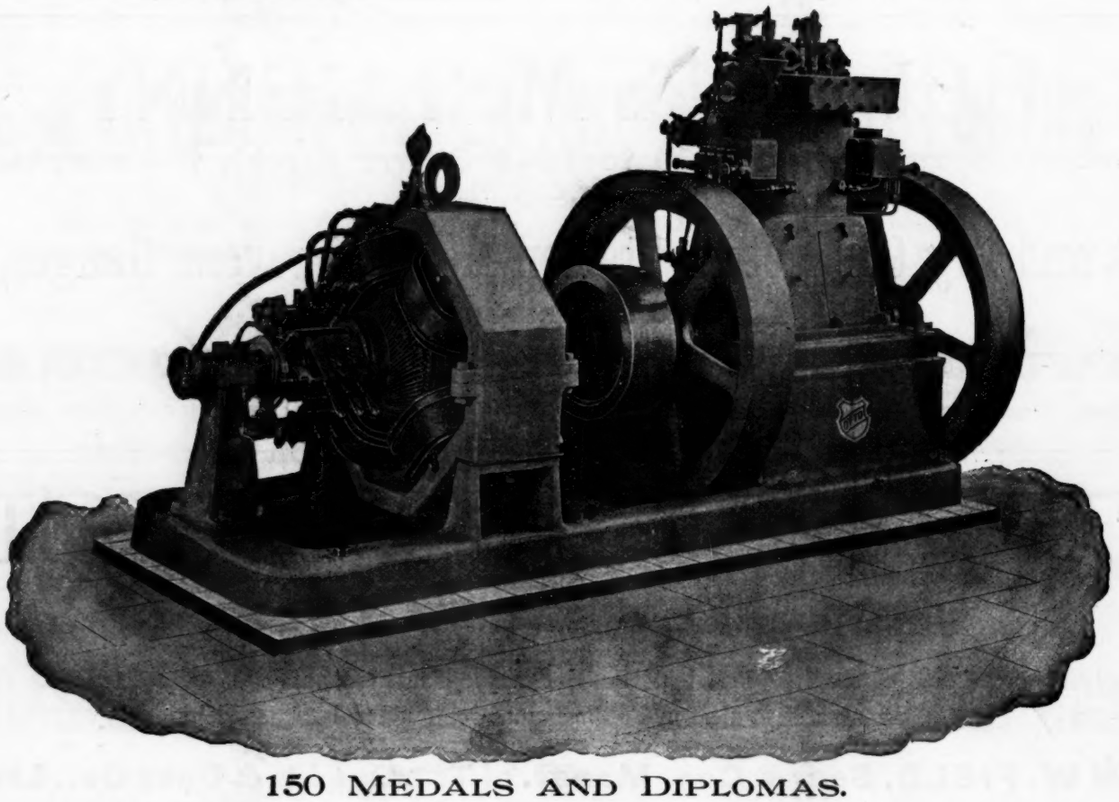

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